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INTEGRATED ENGINEERING SOLUTIONS

WEST LRT TECHNICAL UPDATE:

UPDATED PLAN

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FOR

CALGARY TRANSIT

CITY OF CALGARY

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1 INTRODUCTION

The purpose of this report is to summarize the technical features of the future west LRT line from 10th Street SW in the Downtown to 69th Street SW.

2 THE 2006 UPDATED PLAN

General

All stations are designed to accommodate 4 LRVs.

2.1 Area 1 - 10th Street to 18th Street

2.1.1 LRT Track Alignment

2.1.1.1 Horizontal Alignment

The alignment begins on 7th Avenue just west of the proposed 11th Street LRT Station. There is a low speed 15 kph curve just west of the station to avoid primary building impacts with the Science Centre; the alignment does however impact on the elevated deck and access to the Science Centre. The alignment swings southward through Millennium park in 50 kph reverse curves over 9th Avenue/Bow Trail, 14th Street and the existing CPR trackage. The alignment runs parallel to and south of the CPR trackage and is tangent through the 16th Street Station Area to 18th Street.

This alignment locates the West LRT away from 4th, 5th, 6th, and 9th Avenues SW south of the existing 14 Street interchange structures, maximizing options for any future Bow Trail Connector roadway changes. It also has a secondary benefit of bringing the 16th Street SW LRT Station closer to the population base in Sunalta on the south side of the CPR tracks.

An elevated split platform station is proposed at 16th Street. The platform configuration at this station is driven by the requirement for a turn around pocket track, and cross overs on the downtown side of the station. The station also needs to be situated close to the Bus Depot and approximately centered in the Sunalta Community, service area. A grade separated pedestrian crossing to the Bus Depot and pedestrian linkages north of 9th Avenue SW is also a feature of this station.

2.1.1.2 Vertical Alignment

The vertical alignment continues at-grade westward across 11th Street. Immediately west of the Science Centre, the alignment becomes elevated to cross over 9th Avenue, via a 6% grade across Millennium Park, and

continues elevated to the south side of the CPR trackage. Due to the requirement for a turn around pocket track, and cross-overs east of the 16th Street Station the alignment continues elevated westward through Area 1.

A special structure is required across 14th Street and the CPR trackage with a 70m main span.

2.1.2 Road Network Impacts

A key consideration is the impact of the LRT alignment on the future road network between Bow Trail / 9th Avenue and the Downtown core. There currently is no approved plan for the roadway system although several options have been generated and evaluated. One of the alternatives considered is shown in the 1983 West LRT Study (CALTS 86).

The Updated Plan maximizes the potential roadway network alternatives by elevating the LRT and moving the alignment away from the 4th - 9th Avenue corridor. LRT will cross 11 Street SW at grade similar to other downtown street crossings.

2.1.3 Property Impacts

2.1.3.1 Science Centre/Millennium Park

The Updated Plan impacts the Science Centre elevated structure and access, but not the main building – it may be retained. It is also desirable that the Updated Plan be on structures through the Millennium Park to reduce the pedestrian segregation of the Park. Pedestrian and vehicle access connections for Millennium Park and the Science Centre building will need to be developed at the detailed design stage.

2.1.3.2 Land Acquisition

The Updated Plan requires land in three areas:

- The properties on the southeast corner of 14th Street and 9th Avenue.
- An 18 metre wide easement on the south edge of the CPR tracks within the existing CPR right of way. This easement will require an agreement with CPR. This easement is increased to 24m in the station area.
- Properties immediately north of 19th Street at 10th Avenue.

2.1.3.3 Enmax Transmission Line

The Updated Plan does not impact the Enmax transmission lines, as it crosses them after they are taken underground. However the pedestrian connection to the Greyhound bus depot requires that the line be taken

underground further to the west to permit construction of the pedestrian structure.

2.1.3.4 Canadian Pacific Railway (CPR)

Preliminary discussions with CPR have indicated that the long range plan requires four tracks within their existing right of way. Provision for these future tracks is shown on the drawings. Through the station area the north offset to the future CPR track is less than the required minimum horizontal clearance. Therefore a vertical easement is required and the LRT vertical profile has been adjusted accordingly.

2.1.3.5 Developments and Access

The Updated Plan does not impact the businesses on 9th Avenue or the Bus Depot. It does impact the businesses on the north side of 10th Avenue. These businesses utilize the CPR lands for storage and parking. Since the Updated Plan is constructed continuously on structure with an elevated profile, most businesses could continue to lease the lands underneath the LRT structure.

2.2 Area 2 – Bow Trail from 18th Street to 26th Street

2.2.1 LRT Track Alignment

2.2.1.1 Horizontal Alignment

West of 18th Street, the Updated Plan exits the CPR ROW to parallel EB Bow Trail and then enters two high speed reverse curves crossing over Crowchild Trail and Bow Trail. The alignment then parallels Bow Trail on the north side from 24th Street to 33rd Street.

2.2.1.2 Vertical Alignment

The vertical alignment continues as an elevated guideway with the key vertical control being the crossing of the Crowchild Trail Ramp NB to EB Bow Trail. This requires a 500m long, 6% grade, and results in the LRT guideway being approximately 12m above southbound Crowchild Trail. The vertical alignment comes back to an at-grade situation near 24th Street after crossing Bow Trail and continues at-grade to 29th Street.

2.2.2 Road Network Impacts

2.2.2.1 Crowchild Trail\Bow Trail Interchange

A formal functional planning study has not been undertaken for upgrading of the Crowchild Trail\Bow Trail Interchange. The Updated Plan does not impact the existing interchange configuration; it is located south of the

existing interchange to minimize any potential impacts to any future interchange configuration.

2.2.2.2 Bow Trail

The Updated Plan is located on the north side of the ultimate Bow Trail configuration. The median width has been revised from the recent EarthTech functional planning study to remove the LRT from the median. The elevated crossing of Bow Trail does not impact on the slip ramp connections from Bow Trail to northbound Crowchild and eastbound 10th Avenue.

A 20 degree skewed structure is required for the crossing of Bow Trail. This structure will require column bents in the median and shoulder areas of Bow Trail. These columns will require special roadside treatment on Bow Trail.

2.2.3 Property Impacts

The Updated Plan requires land in 3 areas

- Commercial/Industrial property impacts near the corner of 19th Street and 10th Avenue,
- Residential impacts parallel to Bow Trail at Scarboro Avenue.
- Residential Impacts along Bow Trail between 24th Street and 26th Street, this includes Jacques Lodges.

2.2.4 Impact to Residents

The Updated Plan does not directly impact the residential properties in the vicinity of Bow and Crowchild Trails; however there are some potential view impacts.

2.2.5 Developments and Access

Discussions regarding the redevelopment of Jacques Lodges have occurred with the land owner. The current residents of the cottages are likely to be moved to another site after 2008. The current owners have indicated that a determination of the redevelopment potential will be made in 2009.

The access at 24th Street to Bow Trail will be closed for both LRT development and future widening of Bow Trail. Access from the north leg of 26th Street to Bow Trail will be an at-grade signalized crossing of the LRT tracks.

2.3 Area 3 – 26th Street to 37th Street

2.3.1 LRT Track Alignment

2.3.1.1 Horizontal Alignment

The Updated Plan parallels Bow Trail on the north side from 26th Street to just east of 33rd Street. West of 33rd Street the alignment traverses the Westbrook Shopping Centre site in 2 low speed, 40kph reverse curves to enter into the 17th Street right of way. There are two stations in this section, an at-grade centre loading station at 26th Street and an elevated station at 37th Street. Cross-overs have been located on the downtown side of the 37th Street station and a pocket track is situated on the west side of the 26th Street station. This is the only feasible location for a pocket track on this leg of West LRT east of 69th Street. Cross-overs were not feasible on the downtown side of the 26th Street station due to the presence of a 6% grade and vertical curves east of 26th Street.

Pedestrian connections for the 26th Street Station are via at grade crossings and existing sidewalks.

The Updated Plan through Westbrook Shopping Centre area represents the least impact alignment. An alternative alignment and station location through the site is also indicated on the Drawings and is subject to redevelopment of the site and agreement with the Developer.

2.3.1.2 Vertical Alignment

The vertical alignment continues at-grade from 26th Street to just east of 33rd Street where the profile rises up in a 6% grade to cross over Bow Trail. The alignment continues as an elevated guideway through to 37th Street.

A special structure with spans of approximately 55m is required to cross from the north side of Bow Trail across 33rd Street to the Westbrook site. This structure requires columns in the median of Bow Trail, revisions to 33rd Street and a column in a new median on 33rd Street.

2.3.2 Road Network Impacts

2.3.2.1 Bow Trail

As in the previous section the median of Bow Trail has been reduced to 6m wide since the LRT has been located on the north side. The left turn bay westbound Bow Trail to southbound 33rd Street has been reduce to a single lane from a dual lane with no change in the LOS. This reduces the impact to the golf course and reduces the span length for the special structure.

Bow Trail/33rd Street Intersection Left Turn Analysis

Traffic analysis of the intersection of Bow Trail and 33rd St. was performed using Synchro and City of Calgary traffic forecast data. The model was developed using the proposed lane configuration and two scenarios were run; one with a single westbound left-turn lane and the second with two left-turn lanes. The proposed configuration consists of three through lanes with dedicated turning bays in the east and west directions; and two through lanes in the north and south directions with left turn bays. The lane and turning lane configurations are shown in Figure 1; one left-turn lane is shown for the westbound direction.

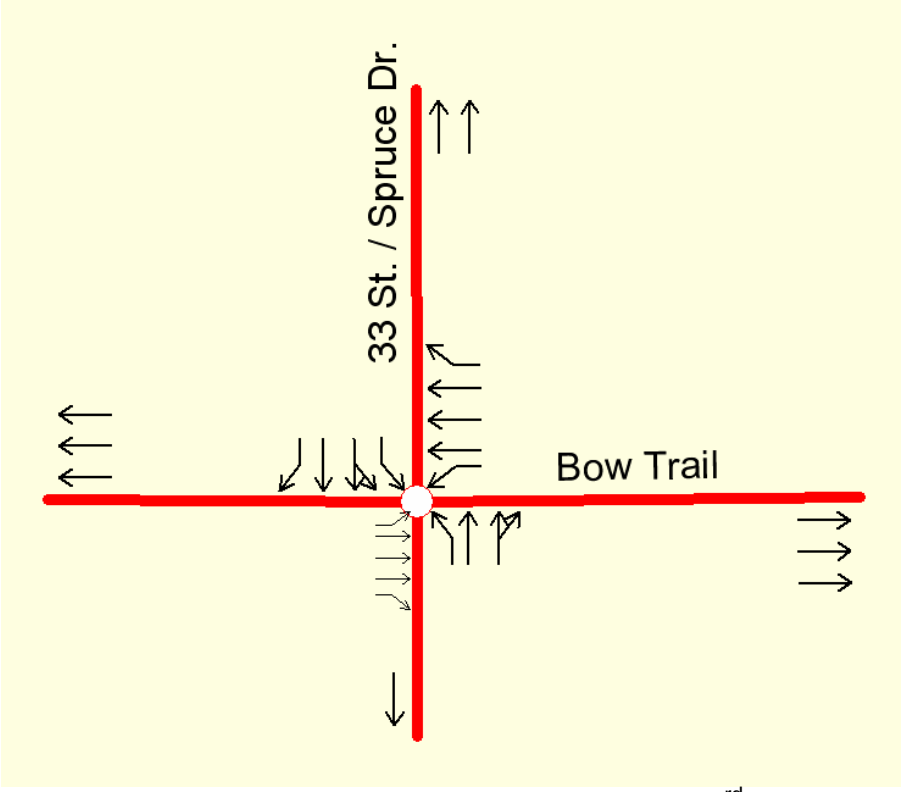

Figure 1: Lane Configuration – Bow Trail and 33rd St.

PROJECTED TRAFFIC

The City of Calgary provided traffic count data that was collected in the 2001 pm and am peak periods. Forecasts were developed for year 2023 adjusted based on predicted network improvements and traffic growth. The principal movements relate to eastbound and westbound directions. Eastbound hourly through traffic is estimated to be 2,660 in the am and westbound through traffic is 2,850 in the pm. These projections are approximately forty percent higher than the counts recorded in 2001.

ANALYSIS RESULTS

Traffic analysis was performed considering the anticipated roadway network to determine the future level of service of the intersection of Bow Trail and 33rd St. From initial analysis, the morning peak period was determined to be the critical case. Two scenarios were examined using Synchro, one with a single westbound left-turn lane and the second with two left-turn lanes. For both am peak period scenarios, level of service (LOS) F was estimated.

Analysis		AM Period	PM Period
Single WB LTL	Overall LOS	E	C
	Internal Capacity Utilization	106 %	89 %
	Volume / Capacity $_{max}$	1.12	.98
	Failing Links (LOS F)	• EB TL • NB RTL • SB LTL	
	WB LTL LOS	E	D
Dual WB LTL	Overall LOS	E	C
	Internal Capacity Utilization	103 %	89 %
	Volume / Capacity $_{max}$	1.12	.98
	Failing Links (LOS F)	• NB RTL • SB LTL	
	WB LTL LOS	C	B

Table 1: Synchro Intersection Analysis Results
LTL = left turn lane, RTL = right turn lane, TL = through lane

CONCLUSION

The Synchro model, used to forecast traffic through the intersection of Bow Trail and 33rd St., shows that a level of service of E is obtained in the am peak period and C in the pm peak period. Adding a second left-turn lane for westbound vehicles to the existing geometry creates negligible improvements to the intersection's functionality.

2.3.3 Property Impacts

The Updated Plan requires land in 4 areas

- Shaganappi Golf Course; preliminary plans for LRT and Bow Trail improvements indicate a requirement for a strip of land up to 33 metres wide from the south edge of the golf course. The widest piece is adjacent to the 26 Street station. This land requirement will be determined with the final design for Bow Trail.
- Commercial/ Industrial/Residential impacts, in the Westbrook Shopping Centre Area, including 2 gas stations and 1 abandoned school. The elevated structure should minimize impacts to these businesses.
- Residential Impacts at the corner of Bow Trail and 33rd Street.
- Commercial property on the south side of 17th Avenue between 35th and 36th Streets.

2.3.4 Impact to Residents

With the exception of the above noted properties, the Updated Plan does not directly impact the properties on the east side of 33rd Street; however there are some potential view impacts from the front yards.

2.3.5 Developments and Access

Re-development of the Westbrook shopping centre area is the key consideration in this section. The final location of the alignment and integration of the 37th Street Station is subject to negotiation with the land owner. Preliminary discussions with the Westbrook Mall owners indicate a preference for an elevated LRT alignment to minimize impacts to future site access.

2.4 Area 4 – 17th Avenue from 37th Street to Glenside Drive

2.4.1 LRT Track Alignment

2.4.1.1 Horizontal Alignment

The Updated Plan parallels 17th Avenue on the north side from 37th Street to Glenside Drive. West of 47th Street the alignment enters into a 65kph curve to follow the alignment of 17th Avenue as it approaches Sarcee Trail. An at-grade centre loading station at 45th Street is proposed, with a cross-over's located on the downtown side of the 45th Street Station.

The potential for a future southward LRT connection to Sarcee Trail is also shown on the drawings. To facilitate this connection across 17th Avenue it is recommended that it be grade separated to eliminate traffic conflicts. The at grade section shown west of the 45th Street Station would become elevated to permit this LRT crossing of 17th Avenue. A decision on this possible connection is required at the design stage for West LRT.

2.4.1.2 Vertical Alignment

The vertical alignment continues as elevated over 37th and 38th Street and comes back to an at-grade guideway at 39th Street. The profile is at-grade from 39th Street through to Glenside Drive.

2.4.2 Road Network Impacts

The Updated Plan on the north side of 17th Avenue allows for unrestricted road access from the south side of 17th Avenue; but has the potential for the following at-grade crossing on the north side of 17th Avenue:

- 40th Street
- 41st Street
- 45th Street
- 47th Street

The designation of the roadway connections to be closed and those to remain open (aside from 45th St) can be determined as part of a community traffic study and consultation process.

All other local street at-grade connections would be closed; proposed local street interconnections on the north side of 17th Avenue are as shown on the Drawings.

Relocation and reconstruction of 17th Avenue in this section is required within the current right of way to allow for the LRT on the north side of 17th Avenue.

2.4.3 Property Impacts

The Updated Plan requires the following land:

- Residential/Commercial properties on the north side of 17 Avenue including 2 churches between 37th Street and Glenside Dr SW.

2.4.4 Impact to Residents

Proximity of the north side residences to the at-grade LRT guideway with respect to noise levels may have to be mitigated in the final design process.

2.4.5 Developments and Access

As per the 1988 Study, the cross section for the 17th Avenue required a 42.7 metre right-of-way which allowed for LRT in the median. Redevelopment along 17th Avenue has been undertaken with adherence to this criteria.

2.5 Area 5 – Glenside Drive to Christie Park Gate

2.5.1 LRT Track Alignment

2.5.1.1 Horizontal Alignment

The Updated Plan parallels 17th Avenue on the north side from Glenside Drive to Christie Park Gate. The alignment enters into reverse 65kph curves to follow the alignment of 17th Avenue as it approaches and goes over Sarcee Trail. One at-grade/ partially retained station is proposed east of Costello Blvd/Sirocco Dr. Cross-over's are not feasible at this station location due to vertical grades and horizontal curves. We have proposed a cross over location 500m east of the station to accommodate the need for crossovers on the downtown side of the stations.

The Signal Hill station has the following features:

- A grade separated pedestrian connection to the Park and Ride/ Feeder Bus Terminal
- At grade pedestrian access from the signalized intersection
- 4 bay, Feeder Bus Terminal
- 3 level, 690 stall parkade for transit users (with allowance for future expansion)
- Kiss and Ride lay-by on 17th Avenue
- Access to the Feeder Bus Terminal and parkade is via an existing traffic signal at Sirocco Drive and Signature Park.

2.5.1.2 Vertical Alignment

The vertical alignment becomes elevated just west of Glenside Drive via a 6% gradient for the grade separated crossing of Sarcee Trail. The profile shown on the drawings is controlled by the vertical clearance requirements to pass over the northbound carriageway of Sarcee Trail.

The alignment returns to grade at Costello Boulevard, and has a 50kph vertical curve constraint for this at-grade crossing. West of Costello Boulevard the alignment climbs up a 6% grade cresting at Christie Park Gate.

2.5.2 Road Network Impacts

2.5.2.1 17th Avenue

The westbound lanes of 17th Avenue will need to be re-constructed to allow for LRT on the north side of 17th Avenue.

2.5.2.2 Sarcee Trail

A formal functional planning study has not been undertaken for the Sarcee Trail \17th Avenue Interchange. Also, the future widening of Sarcee Trail

has not been finalized. As such, it was assumed that the configuration of the future interchange would be similar to the Parclo-B interchange shown in the 1983 Study.

The horizontal and vertical LRT alignments respect this 1983 interchange configuration. Construction of the LRT line may be independent of the future Sarcee Trail Interchange. A functional planning study is recommended prior to the preliminary design LRT phase to confirm the design interface.

At-grade road crossings are also required at Costello Boulevard and Christie Park Gate

2.5.3 Property Impacts

The Updated Plan has only one minor property requirement just east of the Signal Hill Station.

2.5.4 Impact to Residents

Proximity to the at-grade LRT guideway west of Glenside Drive to Sarcee Trail with respect to noise levels may have to be mitigated in the final design process.

2.5.5 Enmax/AltaLink Facilities

Major transmission lines and towers run parallel on both sides of Sarcee Trail. Adjustments for vertical clearance requirements to both transmission lines are likely required for the construction of the LRT structure and for the future construction of the Sarcee Trail \17th Avenue Interchange roadworks. This will require EUB approvals which take 12-15 months prior to construction.

2.6 Area 6 –Christie Park Gate to 69th Street

2.6.1 LRT Track Alignment

2.6.1.1 Horizontal Alignment

The Updated Plan parallels 17th Avenue on the north side from Christie Park Gate to 69th Street, where the potential for a westward extension of West LRT is planned for the north side of 17th Avenue.

The track horizontal alignment has been modified to allow for the installation of cross-over's on a tangent section on the downtown side of the station. The station has also been positioned to allow for tail tracks and an elevated pedestrian access to the proposed Feeder Bus Terminal and parkade.

The 69th Street LRT Station has the following features:

- A grade separated pedestrian connection to the Park and Ride/ Feeder Bus Terminal
- At grade pedestrian connections to existing sidewalks and pathways on the north side of 17 Ave.
- 10 bay, Feeder Bus Terminal
- 3 level, 590 stall parkade of which 150 stalls would be for use by Westside Recreation Centre and 440 stalls for transit users.

2.6.1.2 Vertical Alignment

The vertical alignment remains at grade on a 1.5% gradient through the station area. This is the maximum grade allowed for station areas.

There will also be a future, long term at-grade LRT crossing of 69th Street.

2.6.2 Road Network Impacts

2.6.2.1 17th Avenue

The westbound lanes of 17th Avenue will need to be re-constructed to allow for LRT on the north side of 17th Avenue.

2.6.2.2 Parkade Access (Vehicular)

Vehicular traffic accessing the park and ride facility at the West LRT terminal station can be broken down into three categories as described below:

- Vehicular access to the parking structure, is from a single entrance located directly north of the Westside Recreation Centre (WRC) building within the existing Westside parking lot and is approximately centered in the east-west direction.
- Site access from adjacent roadways is from one of two entrances; at the intersection of 69th St. and Springborough Blvd; the second, right-in right-out only, located between Springborough Blvd and 17th Ave.
- Trip origin impacts vehicular choice in terms of which driveway is used for site access. Vehicles traveling from the north are predicted to access the Parkade by traveling through the WRC site via the intersection of 69th St. and Springborough Blvd while northbound vehicles are predicted to bypass this intersection and enter the site using the driveway to the north. Reconfiguration of the intersection of 69th St. and Springborough Blvd to a roundabout should be considered to minimize internal travel at the WRC site by allowing southbound vehicles to u-turn and use the driveway to the north.

- As an alternative to a roundabout, reconfiguration of WRC parking lot combined with a traffic signal at 69 St and Springborough Blvd and would provide vehicular access to / from the parking structure.

2.6.2.3 Bus Access

Transit and its users are given priority over other vehicular users in the design of the terminal West LRT station. Accordingly, the area to be occupied by the ten bay Feeder Bus Terminal is directly adjacent to the 69th Street LRT Station. Bus access is accommodated from both 17th Avenue and 69th Street. The planned access from 17th Avenue consists of a transit-only median break for buses leaving and entering the site from both left and right directions. Access from 69th Street is intended to be right-in right-out for northbound transit routes using the driveway to the north of the intersection of 69th Street and Springborough Blvd. Buses using this latter entrance will be required to travel past and along the south edge of the parkade facility to access the bus loop area.

2.6.2.4 69th Street/Springborough Blvd.

The construction of the West LRT will generate new trips to the Westside Recreation Centre site. The preferred site layout gives priority to transit passengers and should encourage greater bus use as well as motivate some park and ride users to access the LRT via the Signal Hill Station.

A roundabout is proposed as an alternative to a traffic signal for the intersection of 69th St. and Springborough Blvd. Re-constructing the intersection would permit southbound vehicles to u-turn and then access the park n' ride area via the access to the north of Springborough Blvd. Benefits of the roundabout are decreased travel time for motorists accessing the parking structure and decreased congestion on the Westside Centre site.

Synchro analysis was performed on the intersection of 69th St. and Springborough Blvd. It is assumed that two-thirds of the additional turning traffic to the parking structure is from the north and turns into the Westside Centre site and maneuvers through the parking area. In the case where a roundabout is constructed, southbound travel is assumed to u-turn and access the parkade using the right-in driveway to the north. The results of the analysis are based on:

- Traffic generated – 316 vehicles
- Assumed that 2/3 travel on 69th St. from the north, 1/3 from the south
- Intersection analysis verifying the existing intersection configuration and based on a roundabout configuration

The results are shown in Table 2 below:

Table 2: 69th St. & Springborough Blvd.: Intersection Analysis

Measure	Roundabout	Pre-timed Intersection
Level Of Service (2006)	-	B
Maximum Internal Capacity Utilization (ICU)	50 %	68 %
Maximum Volume / Capacity Ratio	.51	.85
Total Delay	-	53 s

The results of analysis show that the two intersection types are well below capacity.

2.6.3 Property Impacts

The Updated Plan has only one minor property requirement just east of the 69th Street Station.

2.6.4 Impact to Residents

Proximity to the at-grade LRT guideway in the Station area, with respect to noise levels may have to be mitigated in the final design process.

Also proximity of the residential properties to the east of Feeder Bus Terminal with respect to noise levels may also have to be mitigated in the final design process.

2.6.5 Impact to Westside Recreation Centre

The proposed bus terminal and parking structure will require modification / relocation of the Westside Recreation outdoor recreational space, parking and vehicular access facilities on the northwest portion of their site.