O2NL Offline Route
Engineering Degree of Difficulty Criteria
Summary of Assessment

1 Introduction

This note provides a summary record of the scoring developed for the multi criteria assessment (MCA) for the alignment options presented within the 300 m wide preferred corridor and the interchange assessment.

The individuals that have completed this EDOD assessment are:

- Engineering Lead: Jamie Povall, Design Manager (Major Projects), MSc(Eng), CEng (UK), CPEng, CMEngNZ, IntPE
- Geotechnical: Andy Mott, Principal Engineering Geologist, BSc (Geol/Geomorph), MSc (Geotech), FGS, CGeol (UK)
- Local Roads: Keith Weale, Principal Transportation Engineer, BSc(Eng), BEng(Hons), MSc(Eng), CPEng, CMEngNZ
- Watercourses: Andrew Craig, Flood Risk Practice Lead, BSc(Eng) Civil, C.WEM, MCIWEM.

2 Alignment MCA

2.1 Introduction

The core engineering team[1] working on the project design conferenced the most appropriate methods to undertake the Alignment MCA process based on the information available. The team considered the key factors which may constitute engineering difficulty as follows:

- **Structures**: multiple watercourse crossings and other structures
- **Local Roads**: complexity of connecting
- **Earthworks**: volumes & major / complex cuts, cut/fill balance
- **Ground conditions**: requirements for ground improvement
- **Watercourses**: effects on existing water courses
- **Temporary works**: temporary roads, bridges, haul roads, mass haul
- **Utilities**: temporary or permanent relocations

As some of these items were not yet known or there was very little difference between options at this stage of design, they were not considered further, and the team agreed the following should be used to assess the EDOD criteria at this stage:

- **Local Roads:** Complexity of connecting
- **Geotechnical:** Volumes & Major / complex cuts
- **Watercourses:** effects on existing water courses

The following were not considered further for the reasoning stated:

- Structures: no material difference between options
- Ground conditions: insufficient difference between options prior to site investigation
- Temporary works: not yet known, and unlikely to be material difference between options
- Utilities: not yet known, and unlikely to be material difference between options

[1] The team consisted of Jamie Povall (Design Manager), Andrew Craig (Flood Lead), Ken Clapcott (Geotechnical Lead), Andy Mott (Geologist Lead), Jeremy Walters (Structures Lead), Steve Muller (Geometrics Lead) and Keith Weale (Overall Project Technical Reviewer)

The future development aspirations for Gladstone Green (between Tararua and Queen) were noted by the team, but the status of the development was not clear; however the team did not think that the development itself made any material difference to the alignment scoring.

2.2 Alignment sub-criteria considerations

A description of the sub-criteria and approach taken is provided below:

Sub-criteria	Description & Assumptions
Geotechnical	• High level geotechnical assessment based on published geological mapping and topography only (i.e. as yet no detailed geotechnical site investigation testing has been completed) • Slopes assumed to be stable (cuts 1V:2H, fills 1V:3H, as per the 3D geometric model) – not assessed further. • Geology with low variability between alignment options due to narrow assessment corridor – not assessed further. • No significant variation between options for difficulty of ground conditions and liquefaction – not assessed further. • Variable geomorphology at northern and southern end with numerous gullies and slopes and proposed bridges. Results in significant cuts and fills forming basis of this assessment. • Cut/fill balance and useable fill not assessed (given zone based assessment and too many options)
Watercourses	• Fill footprint over watercourses that require watercourse and drain realignments, and scour protection on main river floodplains • No consideration of detailed stormwater management at this stage • No consideration of conveyance and treatment of road runoff at this stage • Utilised flood assessment and catchment modelling work completed to date
Complexity of local road connections	• Complexity of the local road alignment geometry to connect to adjacent local roads • Each alignment option assessed against each local road connection option for each zone • Produced a matrix of possible combinations and permutations of alignment and local road connection options • Highlighted the realistically least favourable alignment option in each zone where applicable • Identified those local road connection options that would not be sensitive to main alignment options in each zone

2.3 Scoring Commentary

2.3.1 Geotech

Northern and Southern zones (Zones A & B, Zones & L) challenging due to incised valleys and therefore subject to greater volumes of earthworks and larger cuts, scoring poorly. Central zones (Zone C through Zone H) less complex with fewer differentiators.

2.3.2 Watercourses

Zones A, B and L identified to be fairly challenging for effects on watercourses, with incised valleys crossing route at low angles. Central Zones (C through to H) scoring better, with lesser or more manageable watercourse effects and perpendicular crossings.

2.3.3 Complexity of local road connections

Clear variability within zones with some fairly large ranges for the local road options. Noted challenges in Zones B, C, F and L for some of the local road options.

2.4 Final Scoring (Unweighted sub-components)

Scoring of each attribute within the sub-component category was undertaken by each lead. This was then conferenced with the EDOD team.

The finalised sub-component scoring is shown below.

Option	Effect on watercourses	Complexity of local road connections	Geotechnical	Averaged score (unweighted)	Rounded Score
A - Green	4	1	4.5	**3.17**	**3**
A - White	5	2	4.0	**3.67**	**4**
B - Cyan	4	1	3.5	**2.83**	**3**
B - Green	4	4	4.0	**4.00**	**4**
B - White	3	1	4.0	**2.67**	**3**
C - Green	1	2	2.5	**1.83**	**2**
C - Purple	3	2	2.5	**2.50**	**3**
C - White	1	3	2.5	**2.17**	**2**
D - Cyan	2	1	3.5	**2.17**	**2**
D - Dark Blue	3	2	3.5	**2.83**	**3**
E - Cyan	2	1	2.5	**1.83**	**2**
E - Green	3	1	3.5	**2.50**	**3**
F - Orange	1	3	2.5	**2.17**	**2**
F - Dark Blue	1	3	2.5	**2.17**	**2**
F - Purple	1	3	2.5	**2.17**	**2**
F - White	1	2	2.5	**1.83**	**2**
G - Cyan	1	1	2.0	**1.33**	**1**
G - Purple	1	1	2.0	**1.33**	**1**
G - White	1	1	2.5	**1.50**	**2**
H - Cyan	1	1	1.0	**1.00**	**1**
H - Purple	1	1	2.0	**1.33**	**1**
K - Cyan	3	1	1.5	**1.83**	**2**
K - Dark Blue	3	1	1.5	**1.83**	**2**
K - Yellow	3	1	1.5	**1.83**	**2**
L - Black	3	1	3.5	**2.50**	**3**
L - Green	4	4	4.0	**4.00**	**4**
L - Orange	4	1	3.5	**2.83**	**3**
L - Purple	5	3	4.0	**4.00**	**4**

2.5 Weighting and Sensitivity Testing

The EDOD team conferenced whether a weighting should be applied to any of the sub-criteria, and considered the question of whether any of the three sub-criteria justified a higher weighting?

There was no real consensus or strong views for or against weighting. Instead the team agreed a better approach was to consider the sensitivity of applying various weightings.

The team looked at three weighting systems: no weighting and then two options where geotech was weighted to influence the scoring more than the other sub-criteria.

The geotech emphasis was because the team expected, of the three sub-criteria, this would likely create more engineering complexity than the other two.

At 40% geotech weighting, there were no difference to any overall score.

At 50%, there was a one point difference to five scores.

On the basis of the scoring being fairly insensitive to the geotech weighting options, the team agreed that weighting was not necessary.

Watercourses	Local road connections	Geotechnical
33.3%	**33.3%**	**33.3%**
30%	30%	40%
25%	25%	50%

2.6 Proposed MCA scoring- Alignments

The EDOD team collectively considered whether the final scoring was a reasonable and representative score for each alignment based on the assessment. The EDOD team does acknowledge that there is a level of professional judgement that needs to be applied in scoring. The team agreed that the scoring was appropriate and adequately represented an overall EDOD score for each of the alignments being assessed.

3 Interchanges MCA

3.1 Introduction

The core engineering team[2] working on the project design conferenced the most appropriate methods to undertake the Interchange MCA process based on the information available. The team considered the key factors which may constitute engineering difficulty as follows:

- **Structures**: multiple watercourse crossings and other structures
- **Local Roads**: Complexity of connecting
- **Earthworks**: Volumes & Major / complex cuts, cut/fill balance
- **Ground conditions**: requirements for ground improvement
- **Watercourses**: effects on existing water courses
- **Temporary works**: temporary roads, bridges, haul roads, mass haul
- **Utilities**: temporary or permanent relocations

[2] The team consisted of Jamie Povall (Design Manager), Andrew Craig (Flood Lead), Ken Clapcott (Geotechnical Lead), Andy Mott (Geologist Lead), Jeremy Walters (Structures Lead), Steve Muller (Geometrics Lead) and Keith Weale (Overall Project Technical Reviewer)

As some of these items were not yet known or there was very little difference between options at this stage of design, they were not considered further, and the team agreed the following should be used to assess the EDOD criteria at this stage:

- **Geotechnical/Geological considerations:** estimated magnitude of earthworks, topography and geological age of material
- **Watercourses:** effects on existing water courses
- **Geometric complexity:** Geometric challenges posed by the interchange/intersection including local road tie-ins

The following were not considered further for the reasoning stated:

- Structures: No clear material difference between options at this stage
- Ground conditions: insufficient difference between options prior to site investigation
- Temporary works: not yet known, and unlikely to be material difference between options
- Utilities: not yet known, and unlikely to be material difference between options

3.2 Interchange sub-criteria considerations

A description of the sub-criteria and approach taken is provided below:

Sub-criteria	Description & Assumptions
Geotechnical	• The assessment relates to geotechnical complexity in connection with soil types (age and composition) and topography. Lowest age (most recent) soils assumed to have poorest engineering properties. • It has not included effects of liquefaction and seismicity and for simplicity assumes these are equal across all options. • The assessment is high level due to the amount of ground information available and local variations within interchanges can be expected. • Assumes roundabouts are constructed at the same level as the expressway with minimal additional earthworks required. • Interchange assessments excludes bridges and bridge foundations and associated retaining structures. • Based on anticipated high level volumes assumed from terrain – assessment has not used modelled design quantities as these were not available
Watercourses	• Fill footprint over watercourses that require watercourse and drain realignments, and scour protection on main river floodplains • No consideration of detailed stormwater management at this stage • No consideration of conveyance and treatment of road runoff at this stage • Utilised flood assessment and catchment modelling work completed to date
Geometric complexity	• Considered challenges for main alignment geometry and for connecting to local roads • Based on some assumptions for anticipated local road connections (such as interchange at South Kuku would need additional local roads to connect into) • Have considered 'wider context' such as Kimberley Road and Tararua Road connections to the existing SH1 • Assessment based on individual locations in isolation, does not consider the series effect (that is how the location would be influenced by intersections / interchanges upstream or downstream) • Demand modelling for interchange and proximate intersections was not available for the assessment

3.3 Scoring Commentary

3.3.1 Geotech

Roundabouts scored well on the basis there is little additional earthworks requirement. Grade separation at South Manakau scored higher due to recent alluvial material with associated earthworks. Grade separation at 1/57 scored poorly due to geologically recent soils.

Northern end options scored well due to oldest soils likely offering greatest engineering performance, and flatter (low-complexity) topography.

3.3.2 Watercourses

Roundabouts generally scored better than alternatives due to less significant works. All Manakau options (other than no connection) scored worse than options through the central portion of the project due to more incised valleys.

At the 1/57 split, roundabout and grade separation scored worse on basis of effect on watercourses here that the bifurcation did not impact.

3.3.3 Geometric complexity

Grade separation at Manakau south and north scored poorly; south option due to watercourse proximity, level crossing and impact on local road connections whereas north option due to Waikawa watercourse and no local roads to connect directly into.

Grade separation or roundabout at Kimberley scored moderately poorly due to local road tie-in challenges here.

The 1/57 bifurcation scored very poorly given the significant challenges with local road connections here that are considered to be majorly problematic. The diamond interchange option also scored poorly due to the challenging local road connection requirements.

3.4 Final Scoring (Unweighted sub-components)

Scoring of each attribute within the sub-component category was undertaken by each lead. This was then conferenced with the EDOD team.

Option	Effect on watercourses	Geometric complexity including local road tie-ins	Geotech / Geological	Averaged Score	Unweighted Score FOR MCA
Manakau - Roundabout at South	3	1	1	**1.67**	**2**
Manakau - Grade Separation at South	4	4	4	**4.00**	**4**
Manakau - Roundabout at North	2	2	1	**1.67**	**2**
Manakau - Grade Separation at North	3	4	2	**3.00**	**3**
Manakau - No Connection	1	1	1	**1.00**	**1**
Roundabout at Kimberley	1	3	1	**1.67**	**2**

Grade Separation at Kimberley	1	3	2	**2.00**	**2**
Roundabout at Tararua	1	1	1	**1.00**	**1**
Grade Separation at Tararua	1	2	2	**1.67**	**2**
Split - Bifurcation	1	5	3	**3.00**	**3**
Split - Roundabout	3	2	2	**2.33**	**2**
Split - Grade Separation	3	4	3	**3.33**	**3**
North Levin - Roundabout	1	1	1	**1.00**	**1**
North Levin - Grade Separation	1	2	1	**1.33**	**1**

3.5 Weighting and Sensitivity Testing

The EDOD team conferenced whether a weighting should be applied to any of the sub-criteria, and considered the question of whether any of three sub-criteria justified higher weighting?

There was no real consensus or strong views for or against weighting. Instead the team agreed a better approach was to consider the sensitivity of applying weightings.

The team looked at a number of weighting systems a shown below:

Watercourses	Geometric / local roads tie-ins	Geotechnical	Change in number of scores
33.3%	**33.3%**	**33.3%**	**-**
30%	30%	40%	0
25%	25%	50%	0
25%	50%	25%	3
50%	25%	25%	1

The weightings were reasonably sensitive to a very heavily weighted 'Geometric / local roads' sub-criterion but not the other sensitivity tests. The team agreed to proceed without weightings.

3.6 Proposed MCA scoring- Interchanges

The EDOD team collectively considered whether the final scoring was a reasonable and representative score for the interchange options tested, based on the assessment.

The EDOD team did note that the assessments for interchanges were more challenging than for alignments, as they were not comparing 'like with like' i.e. it was not comparing one alignment against another. Irrespective, the team felt the assessment was carried out in a robust manner.

The EDOD team does acknowledge that there is a level of professional judgement that needs to be applied in scoring. The team agreed that the scoring was appropriate and adequately represented an overall EDOD score for each of the interchange/intersection options being assessed.

4 Local Road Assessment

4.1 Process

The assessment undertaken for local road schematic options was not a full MCA type assessment. Instead the instructions required the various schematic options to be evaluated using a simple red, amber, green scale for EDOD.

The scoring is provided in Attachment 1.

5 Limitations

The assessment has been completed on the information available at the time of assessment and has necessarily relied upon individual's professional judgement in a number of instances. The team has relied upon senior individuals within their technical fields to undertake this work.

As further information becomes available and more detailed work is completed, it is possible that some of the work completed for this EDOD assessment may need to be revisited.

Rev. No.	Date	Description	Prepared By	Checked By	Reviewed By	Approved By
0	30/06/20	FINAL DRAFT	Jamie Povall	Andy Mott, Keith Weale, Andrew Craig	Selwyn Blackmore	Phil Peet
2	29/07/30	Version 2	Jamie Povall	-	Selwyn Blackmore	Phil Peet

Attachment 1 – Local Road EDOD Assessment

A1 - Taylors Road / PP2O Tie-in - Connect current SH1 via Waitohu stream bridge / Taylors Road		Very poor arrangement for higher volumes
A2 - Taylors Road / PP2O Tie-in - Connect via a new underpass (Taylors Road realignment abandoned)		Requires new structure but likely more appropriate layout for local connections
A3 - Taylors Road / PP2O Tie-in - Connect via a new underpass (Taylors Road via Waitohu Stream bridge)		as above
B1 - South Manakau Road - Reconnect South Manakau Road via an underpass (expressway over)		Watercourses in close proximity so this option better to integrate the expressway bridge and watercourse bridges
B2 - South Manakau Road - Reconnect South Manakau Road via an overbridge (expressway under)		Expressway at grade may need to be lifted due to watercourses meaning higher local road bridge
B3 - South Manakau Road - Sever South Manakau Road and provide access via Honi Taipua Street		Bridge very close to curve on Manakau Heights - need to check feasibility. Questionable whether Honi is suitable route (width, grade)
C1 - Honi Taipua Street - Sever Honi Taipua Street and access via Manakau Heights Drive		No key concerns here
C2 - Honi Taipua Street - Reconnect Honi Taipua Street via an overbridge (expressway under)		As per B3
C3 - Honi Taipua Street - Reconnect Honi Taipua Street via a footbridge only (expressway under), vehicle access via Manakau Heights Drive		Straightforward in itself, however this doesn't detail how SM Road will be dealt with?
C4 - Honi Taipua Street - Sever Honi Taipua Street and create a Mokena Kohere Street footbridge		Requires ~800m of new local road
D1 - North Manakau Road - Reconnect North Manakau Road via an overbridge (expressway under)		Fairly straightforward
D2 - North Manakau Road - Reconnect North Manakau Road via an underpass (expressway over)		More significant bridging and embankment works needed
E1 - Kuku East Road - Reconnect Kuku East Road via an overbridge (expressway under)		Fairly straightforward
E2 - Kuku East Road - Reconnect Kuku East Road via an underpass (expressway over)		More significant bridging and embankment works needed

EQ - Quarry Access - Provide access under the Ohau River Bridge (expressway over)		Needs to avoid extending the bridge structure by a significant length, but no major concerns
F1 - Muhunoa East Road - Reconnect Muhunoa East Road via an overbridge (expressway under)		Preferable to keep EW at grade if connection maintained here
F2 - Muhunoa East Road - Reconnect Muhunoa East Road via an underpass (expressway over)		Lots of fill required here
F3 - Muhunoa East Road - Sever Muhunoa East Road and provide access via Arapaepae Road or Mcleavey Road		Likely most preferable given alignment of Muhunoa, restricted bridge and limited area served by a bridge
G1 - Mcleavey Road - Reconnect Muhunoa East Road via an overbridge (expressway under)		Bridge sight distance and expressway alignment considerations. Also fairly poor intersection onto existing SH1
G2 - Mcleavey Road - Reconnect Muhunoa East Road via an underpass (expressway over)		Large fill requirements and poor intersection with current SH1
G3 - Mcleavey Road - Sever Muhunoa East Road and provide access via Muhunoa East Road or Arapaepae Road		Straightforward but access to east side of Arapaepae, Muhunoa and Mcleavey needs to be considered relative to Kimberley
H1 - Arapaepae Road south of Kimberley Road - Sever Arapaepae Road and provide access via Muhunoa East Road		No concerns
H2 - Arapaepae Road south of Kimberley Road - Sever Arapaepae Road and provide access via Mcleavey Road		As per G1 and G2 above
H3 - Arapaepae Road south of Kimberley Road - Sever Arapaepae Road and provide access via Kimberley Road / new link		Could be a better overall solution than bridge at Muhunoa or Mcleavey, but requires over 800m new road
I1 - Muhunoa East - Muhunoa East, Mcleavey and Kimberley severed, new connecting road built		Requires ~4.2km of new local road; however needs to be considered against the context of an additional EW bridge
J1 - Kimberley Road - Reconnect Kimberley Road via an overbridge (expressway under)		All J options provide some local road challenges, further work required to understand implications, including interchange locations
J2 - Kimberley Road - Reconnect Kimberley Road via an underpass (expressway over)		All J options provide some local road challenges, further work required to understand implications, including interchange locations
J3 - Kimberley Road - Sever Kimberley Road and provide access via Arapaepae South and a new link		All J options provide some local road challenges, further work required to understand implications, including interchange locations
J4 - Kimberley Road - Sever Kimberley Road and provide access via Tararua Road and a new link		All J options provide some local road challenges, further work required to understand implications, including interchange locations
K1 - Queen Street - Reconnect Queen Street via an underpass (expressway over)		This option has been tested previously to ensure feasibility; it has some difficulty but workable

K2 - Queen Street - Reconnect Queen Street via an overbridge (expressway below ground level)		Providing an expressway below EGL: may not be possible here due to ground conditions, drainage and GW. Would add significant expense
L1 - Waihou Road - Reconnect Waihou Road via a new link to McDonald Road		Straightforward - based on the assumption that Macdonald itself can remain, which is uncertain. If it cannot, this option becomes less feasible
L2 - Waihou Road - Reconnect Waihou Road via a new link to Wakefield Street		Not ideal due to layout of p[property boundaries requiring convoluted route or severance, but overall a straightforward connection
N1 - Sorenson Road - Reconnect Sorenson Road via an underpass (expressway over)		Expressway rising grade, however small area served by grade separation
N2 - Sorenson Road - Reconnect Sorenson Road via an overbridge (expressway under)		Sufficient offset from rail line to achieve, however could prove complicated to get back down to grade for local road here
N3 - Sorenson Road - Retain Sorenson Road status quo based on alignment selection		Most preferable solution here
P1 - Heatherlea East Road and Koputaroa Road - Reconnect Heatherlea East Road and Koputaroa Road via an intersection to a new roundabout on SH1		Straightforward option to integrate local roads to roundabout
P2 - Heatherlea East Road and Koputaroa Road - Reconnect Heatherlea East Road and Koputaroa Road via an interchange on SH1		Moderately more complex but not concerning
Q1 - Avenue North Road - Convert to cul de sac, active mode access to SH1 only		No local road concerns

J5 Liverpool Connection - Expressway Over		Likely some complexities
J6 Liverpool Connection - Expressway Under		Likely some complexities
J7 Liverpool Connection - No connection		No challenges if not connected