HIGHWAY CONSTRAINTS, COLLABORATION AND BEST PRACTICE

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ABSTRACT

This paper is intended as a case study to show how a collaborative approach on a highly constrained highway corridor has resulted in an effective best practice stormwater system that meets the objectives of all stakeholders.

The NZ Transport Agency (NZTA) is four-laning a flat length of State Highway One in Christchurch. This will result in a major increase in stormwater runoff from a highly constrained site. Stormwater consents are critical to the project and multi-stakeholder satisfaction is essential.

Design criteria and solutions were developed with the NZTA, Environment Canterbury (ECan), Christchurch City Council (CCC), Selwyn District Council (SDC) and Christchurch International Airport Limited (CIAL).

The constraints include:

- A highway corridor sited over unconfined drinking water aquifers
- Surface water courses that cannot accept more flow
- Only 3.5m width available at each boundary for stormwater systems
- This Road of National Significance (RoNS) must stay in service during extreme events
- Ponding of surface water would raise airport bird strike concerns
- SDC water races must cross the highway
- CCC occasionally discharge large volumes from their water supply network to the corridor
- Traffic loads must be carried across full width
- Traffic safety dictates surface cross sections
- Depths to permeable soils range from under 2m to over 5m.

KEYWORDS

Best practice, resource consents, Roads of National Significance, multi-stakeholder collaboration, NZTA Stormwater Standard

PRESENTER PROFILES

Bruce Apperley is a principal engineer based in AECOM NZ Ltd's Christchurch office. As well as design and consenting of highway stormwater systems, he is involved in the preparation of integrated stormwater management plans and asset management plans and valuations.

Stuart Penfold is a senior planner with the NZTA in Christchurch. His role includes interfacing between the NZTA, local authorities, Environment Canterbury, other key stakeholders and consultants. He has to ensure that the designation and consenting of the RoNS and highway works in the Christchurch area proceed on programme and that consent conditions are appropriate locally, regionally and nationally.

1 INTRODUCTION

Russley Road in Christchurch is a highly congested two lane length of State Highway 1. It carries traffic to and from the airport, as well as acting as a south-north arterial. The highway corridor's strategic importance has been recognised by the Government as being nationally significant, having been identified as a Road of National Significance (RoNS). This acknowledges the role the highway can play in supporting economic growth, reducing congestion and improving safety in the region and sets a priority for its upgrading.

This paper is a case study about the four-laning of Russley Road, between Memorial Avenue and Yaldhurst Road, within the existing designated width. Figure 1 below shows the road and its urban and rural surroundings. It also indicates the flat grade and the degree of confinement and congestion.

The water resources aspects of the project have retained a strong stormwater focus as they have developed. The scope has broadened to include improved baseflow augmentation of the headwaters of the Avon using Selwyn District Council water races, and ongoing management of Christchurch City Council water supply well test discharges.

Water sensitive urban design aspects have been somewhat limited by the restricted corridor width but median plantings and retention of mature trees in place on the corridor boundary will provide a pleasing corridor for users. Low impact traffic constraints have had a major influence on stormwater system design.

As well as improved stormwater management and additional supplementing of flows in the Avon River, positive environmental effects will include improved air quality, improved amenity and public safety improvements resulting from reduced traffic congestion.

Figure 1 Existing Corridor View to North

NZTA'S ROLE

The NZTA is the road controlling authority for state highways in New Zealand and has a statutory obligation to promote an affordable, integrated, safe, responsive, and sustainable land transport system (refer s.94 Land Transport Management Act (LTMA) 2003). The NZTA must also exhibit a sense of social and environmental responsibility which includes avoiding, (to the extent reasonable in the circumstances) adverse effects on the environment. The NZTA has many standards and guidelines to provide guidance in the management of environmental considerations, including urban design guidelines and stormwater management guidelines for the highway network.

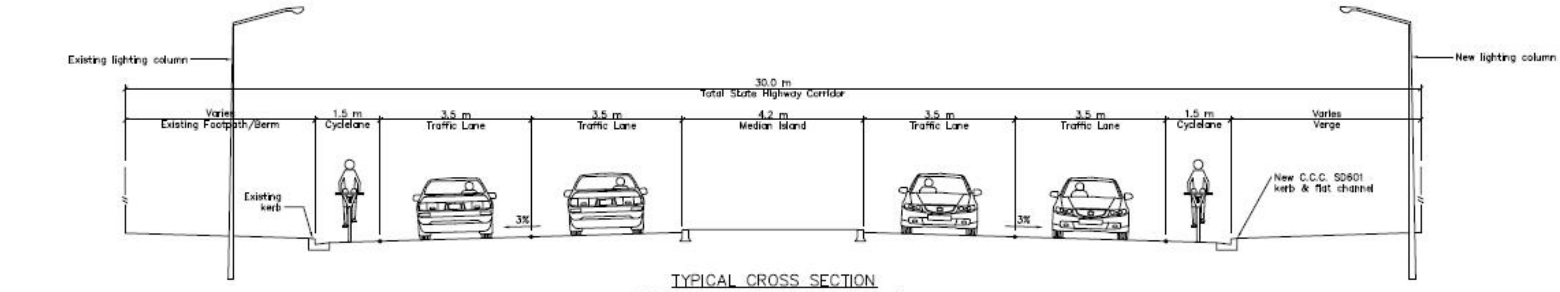
The NZTA's responsibility under the LTMA means that it plays an important role as a partner (along with the Christchurch City Council, Waimakariri and Selwyn District Councils and Environment Canterbury) to the Greater Christchurch Urban Development Strategy (UDS), which is a 35 year plan for managing urban development in the greater Christchurch area. The UDS creates a vision for the future Christchurch to 2041, and integrates key infrastructure with, funding and land use development. The upgrading of Russley Road forms part of the wider transport needs for Greater Christchurch and the NZTA places a high priority on a collaborative approach with its UDS partners. This partnership establishes a good foundation for working constructively on its infrastructure projects.

Russley Road forms part of State Highway 1 and is classified as a Road of National Significance (RONS), indicating that its role as supporting growth, efficient functioning and safe operation is a national priority. The Memorial Avenue to Yaldhurst Road length is currently operating at close to capacity in peak periods. Traffic volumes are expected to continue increasing. To make the best use of available land resources, the NZTA is widening the existing two-laned road to four lanes, while keeping within the existing 30m wide designated corridor.

PROJECT CORRIDOR OVERVIEW

Figure 2 below shows the water-related features of the highway corridor. **Figure 3** shows the design cross sections.

Figure 2 Water Related Features



TYPICAL CROSS SECTION
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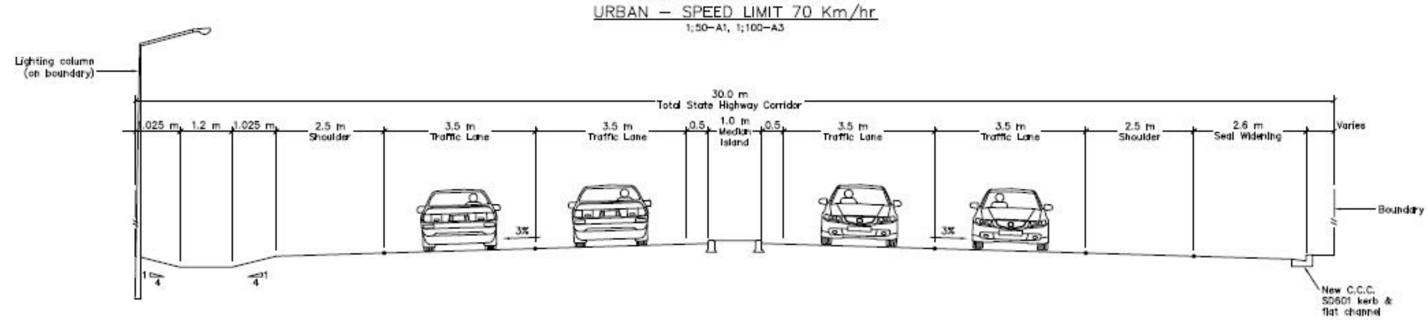
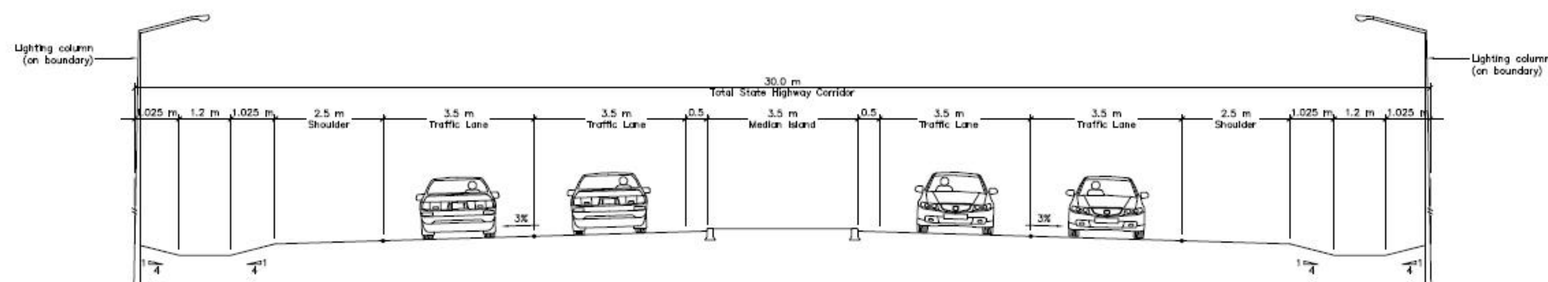


TYPICAL CROSS SECTION
RURAL – (TURNING BAY) SPEED LIMIT 80 Km/hr
1:50–A1, 1:100–A3



TYPICAL CROSS SECTION
RURAL – SPEED LIMIT 80 Km/hr
1:50–A1, 1:100–A3

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A	BMH	31.07.09	Revised for Consultation	

Scales: AS SHOWN

DESIGNED	SC	CHECKED	NB
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APPROVED	NB	DATE	15.07.09

Last saved: Fri, 31 Jul 2009 02:26 pm

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NZ TRANSPORT AGENCY
WAKA KOTAHI

SH1 (RUSSLEY ROAD) MEMORIAL TO YALDHURST 4 – LANING

TYPICAL CROSS SECTION
URBAN AND RURAL

NZTA – 62101 | 60050755–002 | A

Figure 2 Project Features

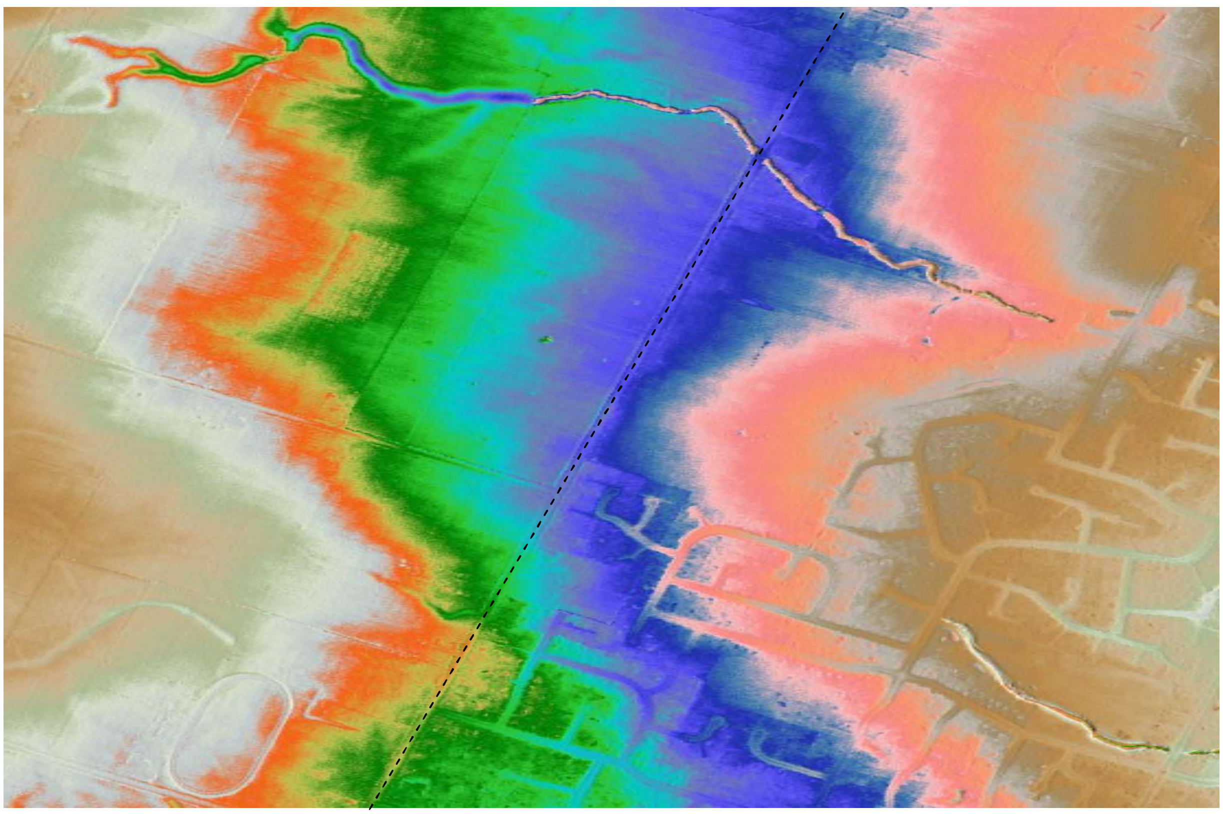
TOPOGRAPHY AND ALIGNMENT

The project area and surrounding land has a general slope of about 1 in 100 downwards to the east south east. Some surface undulations and shallow localised channels are present, resulting from the river outwash processes that formed the Canterbury Plains. The contour image below, provided by CCC from the shared ECan and CCC LIDAR database, indicates some of those undulations and channels in the southern two thirds of the corridor length.

The project corridor is approximately 3,200m in length. It is straight in plan and runs in a SSW direction from just south of the Memorial Avenue roundabout to the Yaldhurst Road intersection.

The road centreline is generally above the surrounding land, except in the dip around the Pyne Gould Stream approximately 1,400m from Memorial Avenue. The road is lower than the surrounding land in this length, and the stream channel is some 4 to 5 metres deeper than the surrounding land in this locality.

The road runs almost parallel to the local ground contours so the overall centreline grade is almost flat. The centreline rises approximately 2.5m from 28.7m above current sea level at the Memorial Avenue start point to 31.2m above current sea level at the Yaldhurst Road intersection. This equates to an overall centreline grade of 1 in 1,280. Localised grades are typically but not always steeper, averaging 1 in 375.



GENERAL ENVIRONMENT

The present highway has been in place for many years. It traverses a key intersection from Christchurch City to the Airport (Memorial Avenue), pastoral farming land and urban residential areas. The current land environment has low ecological, cultural, and historical values. Amenity values are derived from mainly a rural outlook to the Southern Alps and pastoral activities. Generally the site is not particularly sensitive to potential adverse effects arising from this proposal, with the exception of groundwater and surface water, which are discussed below.

GEOLOGY

The site is generally underlain by alluvial gravel, with sand and silt from an historic flood plain in the north (within 200m of Memorial Avenue). Finer overbank deposits (silts and sands), typically in the range of one to four metres thick, lie over the alluvial sandy gravels for the majority of the remaining project length.

Clean water permeabilities in the surficial sandy silts range from 2.5×10^{-7} m/s to 2.5×10^{-6} m/s (1 to 9 mm/hour). Permeabilities in the underlying sandy gravels are high, ranging from 9 X 10-4 m/s (3m/hour) to 1.3×10^{-3} m/s (5 m/hour).

CONTAMINATION

ECan's contaminated sites database does not show any contaminated sites within the project corridor. Groundwater sampling has shown that historical agricultural activities up gradient of the project corridor have been the main cause of groundwater contamination.

GROUNDWATER

Piezometric contours from ECan's GIS mapping indicate that groundwater flows towards the southeast, broadly parallel to the ground surface slope.

Depth to groundwater varies along the corridor. The recorded seasonal range is in the order of 5m. Summer groundwater was found to be approximately 10m below ground level at the Memorial Avenue end and 12m below GL adjacent to the Pyne Gould Stream and at the Yaldhurst Road end.

The project corridor lies within ECan's groundwater recharge Zones 1D and 2. Zone 1D is of particular concern as it lies over Christchurch's unconfined drinking water aquifers.

Groundwater levels will be below the minimum 2m vertical clearance required under ECan's (Proposed) Natural Resources Regional Plan (PNRRP) but will be within the 2 to 10m range where infiltration trench criteria apply.

Discharges of stormwater to ground currently occur within the wellhead protection zone for CCC's community water supply wells near Yaldhurst Road (see Figure 2 above). Those discharges will be transferred outside the protection zone.

SURFACE WATER

Selwyn District Council water races enter the highway corridor from the west at four points. The two at the northern end of the corridor are now unused, but do carry storm flows. In dry weather the two races closer to the southern end discharge excess flows into the corridor. They also carry storm flows.

Water courses from the highway corridor discharge into the Christchurch City Council networks at four locations. CCC has no additional network capacity, so future surface flows must be limited to current levels. CCC has given permission to NZTA to continue existing discharges from the highway corridor to CCC's stormwater networks provided flow rates are no higher than at present and quality is at least equivalent to swale treatment.

The Waimakariri flood plain has an old set of natural distributary channels. One of those crosses Russley Road at the Pyne Gould Stream dip at about 1,500 m. The Pyne Gould channel is usually dry but is expected to carry flows of approximately 4 cubic metres per second from the local catchment during 50 year ARI events.

Much larger overland flows may occur from failures of the Waimakariri River flood protection system. With the present primary stopbank system, overland flow in the order of 1m deep in the Pyne Gould Stream area has been predicted by ECan to occur for 12 to 48 hours every 500 years on average. The recently consented secondary stopbank system, when constructed, will substantially increase the predicted average return interval.

Christchurch International Airport Ltd (CIAL) is planning to construct an industrial area to the west of the highway. Surface flows from that development are expected to be contained within the site and to be discharged to ground.

The corridor intersects a number of surface waterways including stock water races. One of those stock water races and a short ephemeral water course are classified as lowland streams in ECan's Proposed Natural Resources Regional Plan (PNRRP).

Flows from one stock water race are currently carried some distance along and across the corridor to Avonhead Park to supplement flows in the Avon River. These flows are to be augmented with larger, more reliable flows from a closer race, thereby adding further benefits to the project.

The project will also include the construction of new cross-highway culverts to replace existing ones. Existing flow paths will be maintained. Highway centreline heights will not be varied significantly, except at one location (Pyne Gould Stream) where the dip will be filled to allow the highway to continue functioning as a regional lifeline route during extreme events. New cross highway culverts are to be installed at that location.

Spills of contaminants could occur during highway operation. This risk and the potential effects will be managed by the design and management of the stormwater systems.

OTHER UTILITIES

Three high voltage transmission lines cross the corridor. Three of the support pylons are sited within the corridor. They are to be moved to allow clear space for vehicle runoff and for stormwater.

The corridor also contains local overhead and underground power lines and fibre optic and copper telecom cables. There are water supply and sewer pipelines in the residential area at the southern end.

CCC has a water pump station at the southern end of the corridor. Prolonged flows of around 70 litres/second are occasionally discharged to the highway drains during well testing,

WIDTH, AREA AND RUNOFF

The paved width will increase from approximately 12m to 23m, leaving a strip 3.5 metres wide adjacent to each side boundary for stormwater management.

The impervious width as a percentage of the 30m corridor will increase from 40% to just under 70%.

Infiltration rates, and hence peak runoff rates and volumes, will (as now) depend on prior rainfall and on event duration and intensity. For a 5 year 10 minute storm, the peak runoff rate and volume will increase by approximately 20% resulting from the change in impervious area. For a 50 year storm, where lower infiltration rates apply, the peak runoff rate and volume will increase by approximately 12% resulting from the change in impervious area.

CHRISTCHURCH INTERNATIONAL AIRPORT

As shown at the top left of Figure 2 above, CIAL has runways about a kilometre to the west of the corridor. Birdstrike is a major concern for the airport authority and hence ponded water is to be avoided. There are also concerns about grass species. The Argentinian stem boring weevil is a major attractant to birds. It enjoys ryegrass, which is the species of choice for swales in this location. Ryegrass will be inoculated with a fungus to inhibit the weevils.

CONTINUITY OF OPERATION

The project forms part of a regional arterial route of national significance that is required to be available except under extreme event conditions. The highway is a regional lifeline and is required to remain fully operational up to at least 50 year average return interval storms. Limited operation is to be provided up to 200 year ARI storms. The table below shows the criteria for operational availability.

Average Return Interval (Years)	**Swales and discharge points**	**Sealed Shoulder**	**Lanes**
25-50	Operating at capacity	No ponded or flowing water	Fully trafficable
50-100	Capacity exceeded. Ponding occurring.	Stormwater may pond on or flow along the sealed shoulder	Trafficable. Temporary speed restrictions / management may be needed.
100-200	Capacity exceeded. Ponding occurring.	Stormwater ponded on or flowing along the sealed shoulder.	One lane out in either or both directions. Temporary speed restrictions / management.
200 plus	Capacity exceeded. Ponding occurring.	Stormwater ponded on or flowing along the sealed shoulder	Road closed due to flooding crossing the centreline of the road, or blocking all lanes in one or more directions

SELECTION OF BEST PRACTICE SYSTEMS

NZTA's Stormwater Standard and ECan's PNRRP requirements have been used as the basis for design. Rainfalls have been taken from CCC's published information. Climate change has been allowed for with a 20% increase in rainfalls. The outcomes from consultation and stakeholder requirements also influenced the stormwater management approach, as management regimes that did not meet stakeholders concerns had to be discounted.

Options that were considered include:

Permeable pavement surfacing. Open graded permeable asphalt pavement surfacing is a possible option as a first part of the treatment train. Drawbacks include increased cost, reduced life before replacement, and the need to periodically "vacuum clean" the paving layer to remove contaminants and restore permeability. Permeable pavement surfacing may be recommended as a noise reduction measure but will not be relied upon for treatment.

Grassed filtration beds. The side slopes between the outer edge of the sealed shoulder and the swale floors will provide some overland flow filtration.

Swales. Grassed swales are proposed as the main part of the peak flow mitigation and treatment train.

Wet ponds. Wet ponds were not recommended. They could attract birds which would cause bird strike concerns for CIAL. They would also require additional land to be taken.

Wetlands. Wetlands were not recommended. They would have raised similar concerns to wet ponds.

Infiltration trenches. Infiltration trenches were recommended as part of the stormwater management treatment train. They were expected to include a replaceable filter cloth layer to limit passage of sediment into the trenches, boulders as required to provide storage and a granular filter under the boulders in areas of highly permeable ground. Modifications to suit site conditions are described below.

Proprietary infiltration systems. Proprietary infiltration systems were not recommended for this project. Concerns included:

- Traffic loads. The corridor is narrow. Vehicles including maintenance trucks must be able to access the full corridor width. Any stormwater treatment system must be able to carry full highway truck loading;
- Available operating depth and grade are limited near some of the surface water discharge points; and
- Capital and operating costs would be higher than for other options.

Best Practice Combinations

The width, airport, traffic load and other constraints have led to best practice stormwater options over most of the project length being comprised of swales and boulder bed infiltration systems. These will collect, transport, treat and store stormwater before discharging it to ground. The drainage design has been based on NZTA's March 2009 Final Draft Stormwater Treatment Standard for Road Infrastructure. Prolonged ponding of water has been avoided to satisfy CIAL's requirements.

At least 9 minute retention time for water quality storm flows before discharge has, where possible, been provided in the swales. Local features such as at intersections prevent all swales being finished with 9 minute lengths. Grassed filter strips have been added in those locations. Swales and filter strips will generally discharge to infiltration trenches.

Incoming flows from side roads will be treated in grassed verge filter strips and discharged to infiltration trenches in those roads to avoid spilling into the highway corridor.

Inlets from swales to infiltration trenches will be via sump filters to catch coarse material and trapped sumps that will catch hydrocarbons.

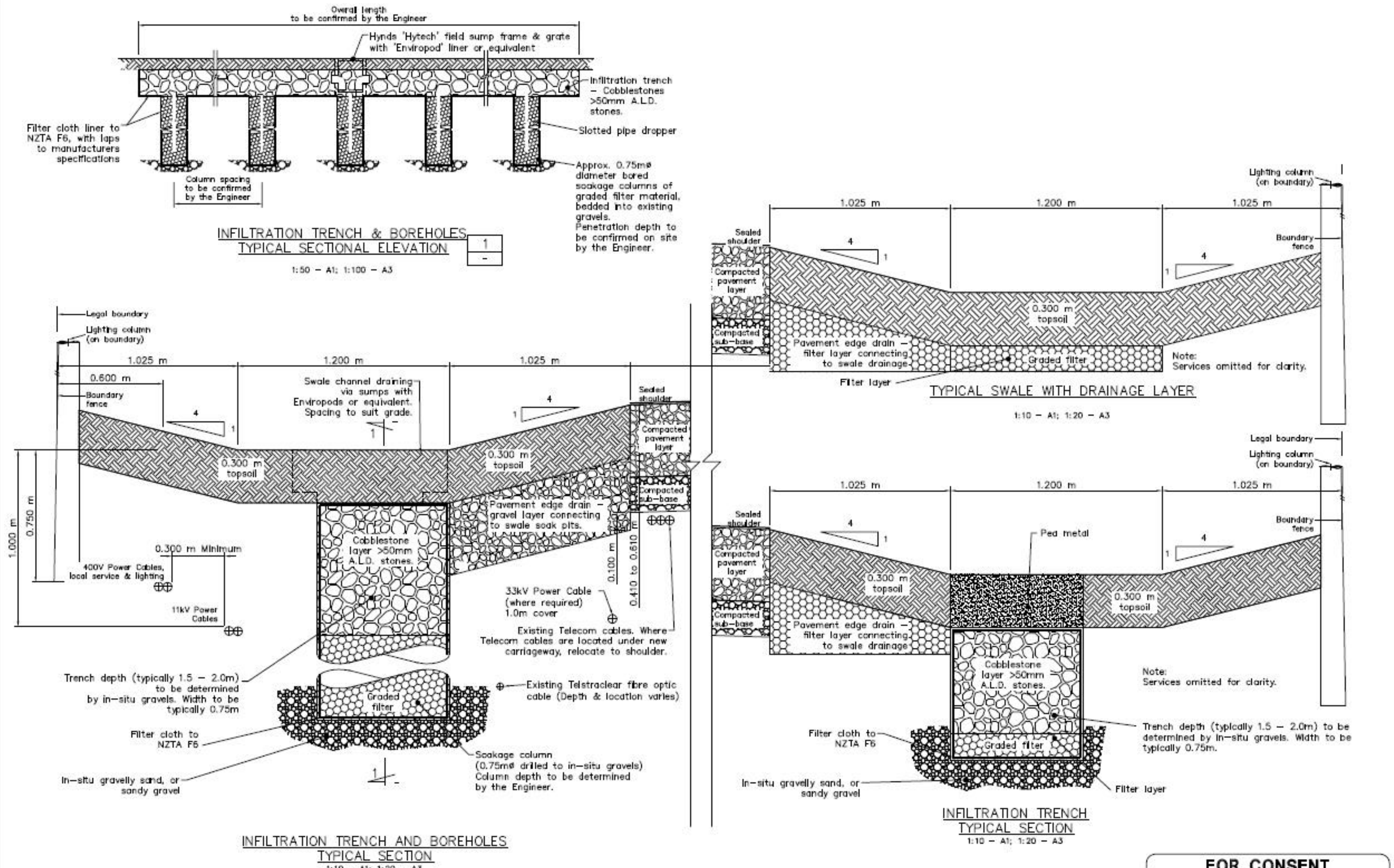
Safe and economic construction of trenches in the cohesionless alluvial materials has been a constraint for discharge to ground. Infiltration trenches will discharge vertically down to the underlying gravels where those gravels are within approximately 2m of the ground surface. Where the gravels are deeper and trenching would be difficult, discharge from the trench bases will be via multiple groundwater recharge bores (dry wells).

The planted median strip separating the opposing lanes will discharge vertically to ground.

The drainage design also accommodates existing occasional short term dry weather high flows of clean groundwater from CCC's water pump station near the southern end of the corridor. Discharges to Avonhead Park, to another CCC waterway or to ground have been allowed for.

A piped water race transfer system will replace the present open channels. That piped system will also carry the occasional water pump station well test discharges.

Figure 4 below shows the design stormwater cross sections.



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A	BWH	30.07.09	Revised for Consultation	BA

Scales: AS SHOWN

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DRAWN	BH	CHECKED	NB
APPROVED	MS	DATE	15.07.09

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NZ TRANSPORT AGENCY WAKA KOTAHI

SH1 (RUSSLEY ROAD) MEMORIAL TO YALDHURST 4 - LANING

TYPICAL RURAL CROSS SECTION
PROPOSED STORMWATER
CONCEPT DESIGN

NZTA - 62101 | 60050755 - 210 | A

CONSULTATION AND COLLABORATION

Consultation had been undertaken over a number of years with neighbouring landowners and known major stakeholders including Ngai Tahu, Transpower, CIAL, ECan and CCC. As the project progressed through to the design phase, further constraints and opportunities became apparent through discussions with stakeholders, and Selwyn District Council became involved in the project with regards to water race constraints.

As the main regulatory authority in the assessment of the project, ECan was involved from early in the project. This project provided an opportunity for a greater level of collaboration with ECan through an initial scoping report outlining the site location, receiving environment and treatment proposed. This report was presented to ECan for its views and. That feedback and further consultation as the project progressed was fed into the resource consent applications.

CCC and SDC were consulted with respect to the surface water constraints of the site and details were worked through with regards to the details of the water race alignments and surface water flows into existing streams.

The final design of the proposed stormwater system has taken the outcomes of this consultation into account, and the nature of the collaboration has meant that effective design solutions have resulted that meet the requirements of the key stakeholders.

RESOURCE CONSENTS

The proposal has been assessed against the Resource Management Act 1991 (RMA) and relevant ECan and CCC statutory policies and plans. Use of the existing designated highway corridor and designing the project to account for the constraints has led to a time and cost efficient outcome. Widening the sealed area rather than replacing the existing road promotes the sustainable management of physical resources and is therefore consistent with the purpose of the RMA. Resource consents are required to discharge stormwater runoff to land during construction and operation, and for work in the two waterways. The earthworks required, while not requiring resource consent, will also conform to ECan requirements.

Best practice stormwater systems are required within groundwater Zone 1D. There are also requirements for working in water ways, including sediment control and protection of downstream land from increased flooding.

Through the focus on the constraints of the corridor during the design process, the project has resulted in no parties being adversely affected by the proposal and the environmental effects being no more than minor. The NZTA requested that the consent applications be processed on a non-notified basis and that resource consents be granted subject to standard conditions. This process is almost complete.

CONSTRUCTION PHASE

The most likely environmental effects will be during construction. A draft erosion and sediment control plan in accordance with ECan guidelines has been provided to demonstrate how the potential effects will be managed. In accordance with NZTA’s own environmental policies and contractual obligations, the successful construction contractor(s) will be required to provide and carry out detailed erosion and sediment control plans prior to construction, also taking ECan’s guidelines into account.

Final design of the infiltration trenches and dry wells will include onsite adjustment as gravel depths are proved.

CONCLUSION

This project has had to be designed to and will operate within an unusual number of constraints. Early engagement with relevant key stakeholders has led to a collaborative approach that has resulted in an iterative design process. This has led to a best practice design that will be robust, reliable and simple to operate and maintain.

ACKNOWLEDGEMENTS

NZTA

Environment Canterbury

Christchurch City Council

Selwyn District Council

REFERENCES

NZTA Stormwater Standard Final Draft March 2009

Christchurch City Council Waterways Drainage and Wetlands Guide 2003