19. STORMWATER & GROUNDWATER

Overview

The key stormwater issues addressed through the proposed stormwater design is the collection and disposal of stormwater generated within the Project, the passage of stockwater race flows beneath the Project and the passage of overland flows generated in the upstream catchment beneath the Project.

The proposed collection and disposal system typically consist of roadside swales and stormwater disposal points to land at regular intervals along the Project. Additional first flush basins are proposed in areas identified as requiring treatment in the NRRP. The design standard for the highway drainage system is the 100 year Annual Recurrence Interval (ARI) rainfall event including an allowance for climate change.

Disposal to land has the potential to reduce downstream flooding, due to the reduction in the area, which currently overflows to the stockwater races in heavy rain and the reduction in outflow to Montgomery's Drain and Upper Knights Stream. This will have a positive effect.

The groundwater has been a key influence in the design of the Project, as it has dictated the vertical level for the road, preventing the placement of the motorway into a cutting. The design requires intervention to control the groundwater level at two specific locations. For the Robinsons Road overpass (where the local road passes under the highway), intermittent pumping of groundwater is proposed. Also, where CSM2 connects with CSM1, in extreme groundwater and/or rainfall events or combinations thereof, dewatering may be required, depending upon predicted changes to groundwater levels as a result of future groundwater level increases unrelated to the Project. The design appropriately allows for these dewatering requirements. The resulting environmental effect on Upper Knights Stream will be minor.

Given stormwater arrangements for the existing State highway, the proposed stormwater treatment process will improve the receiving environment water quality. Overall, the effect of the discharges on groundwater quality will be minor. A number of mitigation measures are recommended in relation to stormwater management.

19.1. Background

The information contained in this chapter is based on Technical Report 3, appended in Volume 3. It describes the stormwater infrastructure proposed for the Project and the effect that it will have on the environment.

There is little existing formal stormwater drainage infrastructure along the length of the proposed works. Untreated existing runoff can easily enter the environment in the following areas:

- isolated soak pits along Main South Road;

- the swale and soak pit system constructed adjacent to the passing lanes outside of Rolleston; and
- the stockwater race network;

However as part of recent works there are stormwater treatment facilities as part of, or in conjunction with the CSM1 project, being:

- the pond adjacent to Meadow Mushrooms (known as the Mushroom Pond) and the Lee Pond; and
- the works proposed in the SWAP being the Owaka Basin and the culvert beneath CSM1 to accommodate discharge from the Owaka Basin to the Wilmers Road Quarry Disposal Area.

The proposed design standard for the highway drainage system is the 100 year Annual Recurrence Interval (ARI) rainfall event including an allowance for climate change, as recommended by the MfE in the local body guidance manual[80].

19.2. Existing hydrological environment

19.2.1. Hydrology

The majority of the catchment crossed by the Project does not directly contribute to any natural watercourse. Surface water typically ponds in local depressions on the catchment surface and soaks to land or evaporates. In larger events, overland flows have the potential to flow along surface flow paths. These overland flow paths are often intercepted by field drains, irrigation channels and the existing stockwater race network, which either eventually discharge to the Halswell River or discharge to land via engineered soak pits.

Stockwater races perform a land drainage function during heavy rainfall events. During or prior to such events, the upstream stockwater race intakes are closed or shut off. SDC advises that runoff can exceed water race capacity and some localised flooding does occur.

The section of CSM2 about Halswell Junction Road is part of the Halswell River catchment. This area drains to the Halswell River via Montgomery's Drain and Upper Knights Stream. Upper Knights Stream is permanently dry at the upstream end. There is a history of flooding in the Halswell catchment where the critical duration storm is up to 60 hours in length.

The Project crosses existing water races. Generally, the stockwater races will be piped beneath the Project alignment, to maintain the stock water race function for downstream users and to provide for the secondary land drainage function of the races.

[80] Ministry for the Environment, July 2008, Preparing for Climate Change, A guide for Local Government

19.2.2. Existing infrastructure and natural features

Typically, the existing road drainage for Main South Road is intermittent with sheet flow off the road discharging into adjacent properties and occasionally directed by informal swales. Formal soak pits can be found on the rural roads in the area and along the existing Main South Road.

Park Lane to Weedons Ross Road

The key existing stormwater features in this section include:

- the passing lane between Rolleston and the Weedons Ross Road intersection where a swale and soakage system has been constructed (with gravel soak pits at approximate 200m centres). A series of shallow swales are observed on both sides of the carriageway draining to land.

The catchment of this stretch of SH1 is gently undulating farmland sloping from south west to north east. There are minimal impervious surfaces in the catchment area and the small portion of surface water runoff will be captured by the existing stockwater race at Weedons Ross Road.

Upstream of the rail embankment is a large catchment area. The rail embankment effectively forms a barrier to overland flow and there is little opportunity for this potential flow to pass under the rail in a very limited number of generally small diameter culverts. Overland flow in the land between the railway and SH1 concentrates to a low point some 500 m south of Weedons Road. Initially soakage to land will occur however when exceeded then this eventually overflows and discharges to the highway drainage system. In events exceeding the capacity of the soak pit, flooding of the current stormwater infrastructure would occur.

Weedons Ross Road to MSRFL/CSM2

There are two existing stockwater races in the vicinity of Weedons Ross Road:

- one adjacent to Weedons Ross Road: this race continues to the South-East running parallel to Weedons Ross Road; and
- a second that arrives to the North-West of SH1 chainage 3175 m: this race turns east and conveys parallel to SH1 to chainage 3475 m where it crosses below the existing carriageway heading south into farmland.

Six potential overland flow paths have been identified from the west. These are located in low points in the existing topography and have the potential to convey overland flow in extreme storm events to the highway drainage system.

The catchment of this stretch of SH1 is gently undulating farmland sloping from south west to north east. There are minimal impervious surfaces in the catchment area and a portion of surface water runoff will be captured by the network of existing stockwater races.

There is a super elevation[81] in the highway carriageway adjacent to, and just past, the Weedons Ross Road interchange. Surface water runoff from the existing road surface will flow to the north only, captured by the stockwater race and pass under the existing highway.

MSRFL/CSM2 to Blakes Road

The proposed CSM2 alignment crosses a number of surface flow paths (e.g. old river braids), which are likely to carry overland flows in extreme events.

An existing stockwater race flowing south runs along the west side of Robinsons Road, crossing below SH1 at approximately chainage 350m.

Various stockwater races will be encountered with the new alignment and these will be incorporated into the stormwater drainage design to ensure that their function and performance will not be adversely affected.

The required excavation depths for the Robinsons Road overpass are significant (approximately 6.5 m). The depth of the excavation forms a significant design constraint, especially with regards to stormwater disposal and compliance with the NRRP (1 m clearance between disposal depth and highest inferred groundwater depth).

Runoff from the site on the north west corner of the Robinsons Road intersection (beyond the Project footprint) may be contaminated and therefore should not be allowed to reach any proposed stormwater treatment or conveyance areas within the proposed CSM2 drainage layout.

Existing stockwater races will require diversion or need to be piped below the CSM2 alignment.

Blakes Road to Springs Road

The Marshs Road stockwater race currently intercepts two potential overland flow paths originating from industrially zoned land. Runoff from catchments upstream of the Motorway flow to the Project area. This occurs now and is independent of the Project. The Project proposes to capture these flows and divert these flows to a realigned Marshs Road stockwater race.

Existing stockwater races and intercepted overland flow paths will require diversion or need to be piped below the CSM2 alignment.

Springs Road to CSM1

On the north west side of the CSM1 alignment and Halswell Junction Road, is the existing pond adjacent to Meadow Mushrooms (part of the CSM1 works).

Montgomery's Drain runs parallel with Halswell Junction Road starting near the Halswell Junction Road roundabout and heading south east for approximately 550 m before entering a piped

[81] Super elevation is the raising of the outer edge of the road providing a banked turn, thus allowing vehicles to travel through the curve at higher speeds than would otherwise be possible if the surface was flat or level.

system. The 750 mm diameter pipe heads away from Halswell Junction Road to the south where it discharges to an open channel which continues to the south before heading south-east near the end of John Paterson Drive. This open channel then discharges to the Upper Knights Stream.

The CCC Owaka Basin stormwater treatment pond (constructed concurrently with CSM1) has been designed to capture overflows from the Halswell Junction Road Pond (via Montgomery's Drain) and provide additional stormwater treatment. The normal discharge from the Owaka Basin is to the north (beneath CSM1) to the Wilmers Quarry site in events up to the 50 year design storm. Once the capacity is exceeded, the system will overflow south under Halswell Junction Road into Montgomery's Drain and Upper Knights Stream.

The most northern section of CSM2 is part of the Halswell River catchment. This area drains to the Halswell River via Montgomery's Drain and Upper Knights Stream.

The Project will cross Montgomery's Drain which runs parallel to Halswell Junction Road. The drain collects flows from the existing Halswell Junction stormwater retention basin and eventually discharges into the Halswell River. Siphoning of this drain beneath the Project alignment will be required as well as diverting the drain to the CCC Owaka Basin (in order to meet with the CCC design set out in the SWAP).

19.3. Design philosophy

This section provides a summary of the stormwater design philosophy adopted for the Project. Full details can be found in Technical Report 3.

There are four key stormwater issues which need to be addressed with the proposed infrastructure:

- collection and disposal of stormwater generated within the Project;
- passage of stockwater race flows (both wet and dry weather) beneath the Project;
- passage of overland flows generated in the upstream catchment beneath the Project; and
- adaptation and integration of installed detention and collection systems.

The key elements of the stormwater design philosophy, as outlined in Chapter 4 include:

- separation of the Project drainage system from the surrounding surface water and stormwater systems, and from stockwater races;
- stopping overland flows from entering the Project drainage system and flooding the high speed carriageway;
- design for the 100 year ARI event;
- designing for rainfall intensity as per the Waterways, Wetlands and Drainage Guide (WWDG) (CCC, 2011 update). This update incorporates the effects of climate change as recommended by MfE;

- the Project vertical alignment has only two sag or low points with considerable contributing area, located at Weedons Ross Road and Halswell Junction Road;
- treatment of stormwater will be achieved primarily by via sheet flow over the grassed verge and treatment swales;
- in addition and where required by the NRRP (in the less than 6 m to groundwater zone), first flush basins are also included; and
- detention ponds (Maize Maze pond and Ramp ponds).

The collection and disposal system will typically consist of roadside swales and stormwater disposal points at regular intervals along the Project. Additional first flush basins will be required at the eastern end of the Project. This area is where the NRRP prescribes pre-treatment for stormwater prior to disposal because it is within the zone there is less than 6 m to the groundwater zone (as indicated on the planning maps). There will be two pond areas adjacent to Halswell Junction Road (the Maize Maze Pond and the Ramp Ponds) to collect stormwater from the Project in the immediate vicinity.

The stockwater races will be conveyed beneath the Project via inverted siphons. The siphons will consist of a smaller diameter pipe to convey dry weather or 'typical' flows, with a second larger diameter pipe to pass flood flows beneath the Project.

The Project alignment also crosses a number of adjacent stream channels and depressions. In extreme rain events these have the ability to convey large overland flow. A second series of siphon pipes will convey this flow under the motorway to the downstream side of the motorway.

There are a number of locations where discharge of stormwater to land will occur:

- infiltration through the base of the swales;
- discharge at the Project highway drainage soak pits (after swale treatment);
- discharge through the Project drainage pits following pre-treatment as prescribed in the NRRP rule WQL6 (to be used in areas where it is less than 6 m to the groundwater zone (as indicated on the planning maps);
- in the Project ponds located at Robinsons Road and Halswell Junction Road (the Maize Maze Pond and Ramp Ponds;
- the overland flow soak pits intended to discharge flows which cannot be passed beneath the Project both within and outside of the area mapped with groundwater depths greater than 6m;
- the base of the overland flow siphon inlet and outlet structures; and
- the base of the secondary siphon inlet and outlet structures at stockwater race crossings.

The locations where discharge of stormwater and groundwater to surface water will occur, predominately when the design rainfall and / or groundwater levels are exceeded, have been identified in Figure 51 below, with discharge descriptions and frequency outlined in Table 32.

Figure 51: Stormwater discharge to surface water locations

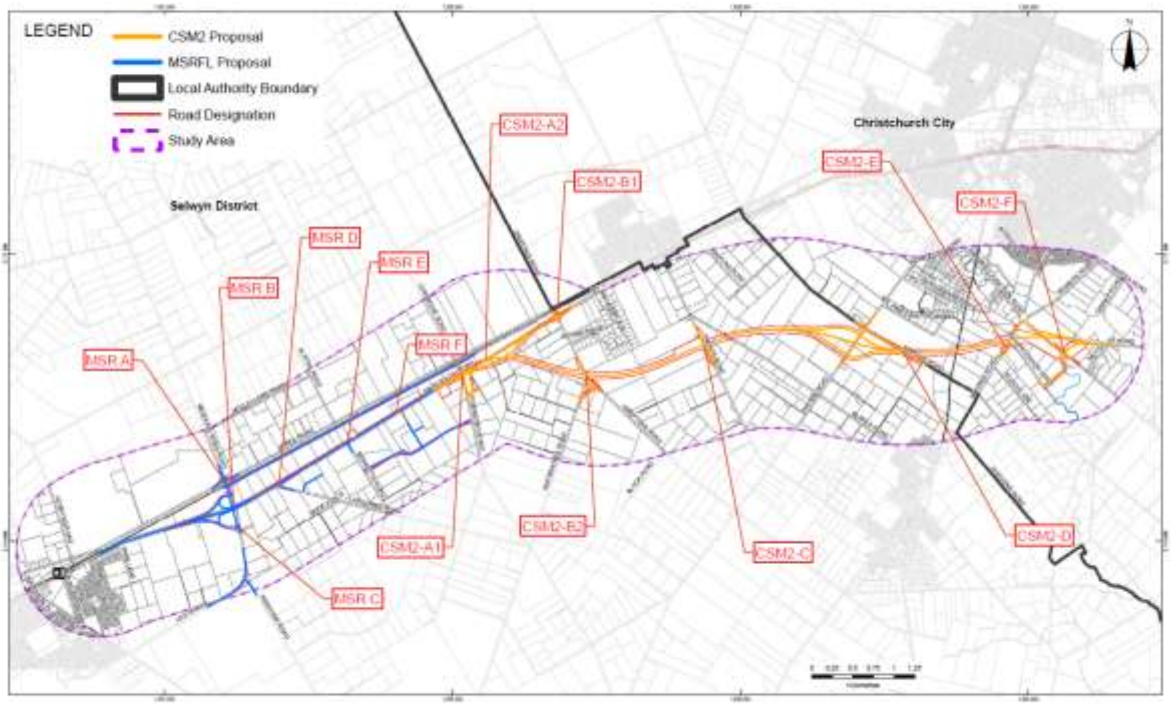

Table 32: Description and frequency of discharges shown in Figure 50

Discharge location number	Description	Discharge frequency
MSRFL		
MSR A	Discharge from local road to stockwater race at Weedons Ross Road	Rare - large storm only
MSR B	Discharge from embankment / swale overflow to stockwater race at Weedons Ross Road	Rare - large storm only
MSR C	Discharge from embankment / swale overflow to stockwater race at Weedons Road	Rare - large storm only
MSR D	Discharge from swale overflow to stockwater race at Larcombs Road	Rare - large storm only
MSR E	Discharge from swale overflow to stockwater race at Berketts Road	Rare - large storm only

Discharge location number	Description	Discharge frequency
MSRFL		
MSR F	Discharge from swale overflow to stockwater race	Rare - large storm only
CSM2		
CSM-A1	Discharge of groundwater to stockwater race at Robinson Road	Intermittent and only after CPWES effects felt
CSM-A2	Discharge from embankment to stockwater race approx 100m north Robinson Road	Rare - large storm only
CSM-B1	Discharge from swale overflow to stockwater race at Waterholes Road (Adj SH1 intersection)	Rare - large storm only
CSM-B2	Discharge from embankment to stockwater race at Waterholes Road (Adj CSM2 intersection)	Rare - large storm only
CSM-C1	Discharge from embankment to stockwater race at Trents Road	Rare - large storm only
CSM-C2	Discharge from existing local road (Blakes Road) to stockwater race at Blakes Road	Rare - large storm only
CSM-D	Discharge from embankment to land drainage race at Marshs Road	Rare - large storm only
CSM-E	Discharge from embankment to land drainage race at Springs Road	Rare - large storm only
CSM-F1	Discharge of pond overflow to Montogomery's Drain adjacent Halswell Junction Road	Intermittent
CSM-F2	Discharge of groundwater to Upper Knights Stream adjacent John Paterson Drive	Regular after effects of CPWES

19.3.1. Design rainfall

Rainfall figures incorporating climate change have been used in the design of the Project. The predicted mid-range effects of climate change were added to the 100 Year ARI rainfall event to ensure that the assessment of effects would be appropriate for the foreseeable life of the asset being constructed (i.e. 2.1℃ to 2090). Subsequent to the initial design work for the Project, CCC released a 2011 update to the WWDG that incorporates the effects of climate change in line with the MfE (2008) recommendations.

For the determination of flows within and across the Project, the 24 hour rainfall depth has been used to determine average flow rates. Further details can be found in Technical Report 3.

19.3.2. Design runoff rate

The design rainfall figures have been used in conjunction with the United States Soil Conservation Service (SCS) method to establish the peak runoff rate from the Project and from the adjacent rural catchment.

The peak discharge for the critical duration event has been established using the unit hydrograph method, as specified in Auckland Regional Council Guidelines for Stormwater Runoff Modelling in the Auckland Region, TP 108, April 1999.

The proposed discharge rates for the Project are set out in Table 33 below.

Table 33: Proposed stormwater discharge rates

Storm Profile	Return Period	Q100	Q100	Q100	Q10	Q2
	Duration	30 min	2 hr	24 hr	24 hr	24 hr
MSRFL						
Runoff rate from 200m typical section of swale	Peak Runoff (l/s)	69	45	9	5	3
(Half carriageway plus berm area incl swale)	Disposal Rate (l/s)	5	5	5	5	5
	Discharge Volume (m^3)	160	300	750	470	280
CSM2						
Runoff rate from 300m typical section of swale	Peak Runoff (l/s)	118	85	12	7	4

Storm Profile	Return Period	Q100	Q100	Q100	Q10	Q2
	Duration	30 min	2 hr	24 hr	24 hr	24 hr
(Half carriageway plus berm area incl swale)	Disposal Rate (l/s)	33	33	33	33	33
	Discharge Volume (m^3)	290	560	1030	630	370
Local roads	Peak Runoff (l/s)	50	33	5	3	2
Runoff rate from 200m typical section of swale	Disposal Rate (l/s)	5	5	5	5	5
	Discharge Volume (m^3)	120	220	480	290	170

19.3.3. Overland flows

Site design will aim to reduce the effect of the Project on overland flow and runoff conditions. The natural and existing drainage network will be utilised as much as possible and only diverted or re-formed should it be absolutely necessary.

The area around the inlets to the overland flow siphons will be lowered to construct a settlement area (to reduce the volume of silt entering the system) and to limit the elevation of the inlet. The motorway cross drainage will be designed to capture overland flows and to pass this flow beneath the alignment.

In addition to the overland flow siphons, cross drains will be provided within the Project drainage system at a higher level, with entry sumps just below the height of the top of the bund in the swale.

It is expected that during the detailed design process and/or the construction phase there may be opportunity to rationalise the number of newly identified and/or currently proposed crossing points. It is proposed that any modifications to the design adhere to the following criteria:

1. an investigation into the upstream effects is made in conjunction with the design of siphons under the Project alignment;
2. a design process is undertaken to avoid any increase in upstream habitable floor level flooding in events up to the 50 Year ARI 24 hour event; (i.e. zero afflux);
3. a design process is undertaken to avoid any increase more than 250 mm in flooding depth for events up to the 100 Year ARI event (i.e. max afflux level of 250 mm);

4. an investigation of the downstream effects is made as a consequence of concentrating flow to a point discharge; and
5. a design process is undertaken to avoid any increase in downstream habitable floor level flooding in events up to the 50 Year ARI 24 hour event.

There are some isolated locations where siphon arrangements are not practical, such as the Shands Road and Weedons Ross Road interchanges. Soakage areas for disposal of overland flows have been proposed at these locations.

19.3.4. Stockwater races

Nine stockwater races cross the Project alignment. Many or all of these races are piped under the existing SH1 and local road network. Some of the races are in pipes at grade, with the balance depressed under the carriageway in pipes using the (inverted) siphon principle.

A series of proposed siphons will be used to convey stockwater races from one side of the MSRFL and CSM2 alignments to the other. A second parallel pipe has been proposed to maintain the land drainage function of the races and to prevent flooding immediately upstream of the crossing points.

A 'spillway' is proposed near the crest of the existing water race to allow the activation of the second, normally dry pipe. Thus after a significant rainfall event has passed, the secondary siphon pipe will drain to a short soakage trench and drain away leaving a dry pipe.

Closure of stockwater races is proposed in a limited number of locations. Given the likelihood of penetrating the porous subsoil layers, the races may have to be lined to prevent water loss.

19.4. Stormwater effects

19.4.1. Water quality

The disposal points proposed for the Project can be divided into two types:

- Road drainage disposal, where the catchment is limited to the road corridor (typical contaminant sources include: vehicle emissions, pavement wear, tyre wear, litter, spills and brake wear) and where runoff will be treated within the system prior to discharge; and
- Overland flow disposal, where the catchments are much larger but mostly rural (typical contaminant sources include: agricultural chemicals and fertilisers, animal faeces and silage leachate) and where runoff will be untreated prior to discharge but will likely to occur only in large rainfall events.

Vehicle emissions include volatile solids, hydrocarbons and pollutants generated by the everyday passage of vehicles. Tyre wear and vehicle corrosion all contribute, together with substances released from the wear of the paved surface.

The design philosophy includes separation of runoff from the Project, from the surrounding environment (overland flows, stockwater races and supply wells). The stormwater runoff from the Project will be treated as it flows through the grass verge and along the treatment swale, prior to soakage to land. This stormwater treatment process will improve the receiving environment water quality.

Estimated contaminant loads

The type and level of contaminants expected in the Project swales is assessed in Appendix F, Technical Report 3. The key findings from this assessment are set out below.

Contaminant loads have been assessed using two methods, the Auckland Council's Contaminant Load Model, 2006 and an approach recommended in the Moore's study[82] that is specific to zinc and copper load generation from motorways. The Moore's study approach is considered more accurate for these metals than the Auckland Council's version as that version has contaminant loads determined from central Auckland streets, which would be expected to be considerably higher relating to continual accelerating and braking, contributing to greater contaminant loads than is likely to arise from this Project.

Using these approaches, estimates for total suspended sediments (TSS), zinc, copper and total petroleum hydrocarbons (TPH) loads/year are as follows:

- TSS – 92,880 kg/year;
- Zinc (normal traffic) – 67.9 kg/year;
- Zinc (congested traffic and intersections) – 150.3 kg/year;
- Copper (normal traffic) – 11.2 kg/year;
- Copper (congested traffic and intersections – 23.01 kg/year; and
- TPH – 5,832 kg/year.

Assuming a mix of congested traffic (25%) and normal traffic (75%) the annual loads for the Project are (from the Moore's study) the following:

- Zinc – 89.12 kg/year; and
- Copper – 14.2 kg/year.

It is noted that pH has been measured on a number of projects internationally and while there can be variations from about 5.1 – 8 pH units, pH is generally a nearly neutral solution from highways, so should not be a concern for this Project.

Swales have been the subject of numerous studies both in New Zealand and internationally. The Moore's study determined removal rates for total copper and zinc. Contaminant removal of TSS by swales was done using the Auckland Council's TP 10, which is 75%. The NZTA stormwater

[82] Moores, J., Pattinson, P., Hyde, C., March 2010, Enhancing the control of contaminants from New Zealand's Roads: Results of a road runoff sampling programme, National Institute of Water and Atmospheric Research Ltd., New Zealand Transport Agency research report 395.

treatment standard uses a similar design approach and should achieve the same treatment expectations.

Table 34 provides removal expectations for the proposed swales for the contaminants listed above.

Table 34: Contaminant removal estimates for proposed swales

Contaminant	Load (kg/year)	Load reduction factor	Load potentially exported (kg/year)
TSS	92,880	0.75	22,220
Zinc	89.12	0.8	17.8
Cooper	14.2	0.8	2.8
TPH	5,832	0.57 (AC contaminant model)	2,506

The potential for contamination is of greatest concern in areas with well-drained soils, typically sand with low organic content, and where the water table is shallow. The TSS load discharged is not an important issue for this Project, as sediment will be effectively trapped in the soil matrix. This results in a maintenance issue rather than a groundwater discharge issue. The effects of zinc, copper and TPH relate to groundwater and are discussed below in Section 19.5.3 in relation to groundwater effects.

The design of the Maize Maze and Ramp ponds further mitigates the effects of contaminants generated in road runoff prior to discharge to the receiving environment. Utilisation of total storm detention in the 100 year 24 hour rainfall event will ensure that spilling to Upper Knights Stream in the Halswell River catchment, via Montgomery's Drain, will only occur in extreme rainfall and/or groundwater events where dilution will be significant.

The Project will also have an effect on the traffic volumes along the existing road network with some traffic predicted to shift off SH1 onto CSM2 and increase along MSRFL. The change in traffic volume as a result of the Project will alter the quality of the stormwater runoff being disposed to land. Traffic volumes will reduce on the existing, untreated length of SH1 north of the CSM2 connection point, so effects here will reduce as a result of the Project.

Treatment objectives will be met with a treatment train approach incorporating sheet flow across grass, water quality swales, first flush basins (where required) and controlled percolation rates (where required). The NRRP allows untreated road runoff to be disposed to land for much of the proposed alignment and the entire Project will receive some treatment in the swale system prior to discharge to land. The design details for these features are discussed in the next sections.

First flush treatment

The principle of first flush capture and treatment is that many of the contaminants accumulate on surfaces such as roads and roofs during dry periods. These contaminants are then removed by small storms or during the first part of longer duration, larger storms.

A conservative first flush treatment depth of 25 mm has been chosen to ensure compliance with local design guidance.

Design criteria for swales

The design criteria used for swales design to improve water quality are set out in Table 35 below:

Table 35: Design criteria for swales

Parameter	Criteria	Comment / Source
Longitudinal slope	Typically 0.5% to 1% Minimum 0.3%	Flatter than standard, but acceptable given permeable subsoil and considered to be Best Practicable Option (BPO) to minimise road corridor
Maximum velocity	0.8 m/s	NZTA Standard [83]
Design vegetation height	100 – 150 mm	NZTA Standard
Typical water depth above vegetation	Should not exceed design vegetation height under the treatment design storm	NZTA Standard
Bottom width	0.6 to 2 m	NZTA Standard
Hydraulic residence time	9 minutes (minimum)	NZTA Standard
Maximum catchment area served	4 ha	NZTA Standard
Minimum length	30 m	Typical spacing is 300 m

[83] NZTA Stormwater Treatment Standard for State Highway Infrastructure, May 2010

Parameter	Criteria	Comment / Source
Side slope	1 V : 4 H on road side. 1 V : 4 H target on back of MSRFL swales, however localised steeper sections at transitions to culvert entrances and at pinch points	Steepened rear faces to MSRFL swales to minimise road width and impacts of land purchase on adjacent property owners. 1:4 enables the swale to be mown safely.

Organic filter layers

The NRRP specified permissible disposal rates range between 20mm/hr and 50mm/hr for the organic filter layer in the first flush basin where infiltration is the design treatment.

The proposed treatment solution in the less than 6 m to groundwater area for the Project includes swale treatment and first flush capture and treatment.

The first flush flows will be disposed through an organic filter media with a specification for the soil properties (material size and organic content) rather than percolation rate. The same specification for laying the filter material has been approved by ECan for the CSM1 project and was determined in accordance with the Stormwater Biofiltration Systems, Adoption Guidelines: Planning, Design and Practical Implementation, Version 1, (Facility for Advanced Water Biofiltration, Monash University, June 2009).

Soak pits

Soak pits are proposed at the ends of swales where the mapped depth to groundwater level is greater than 6m, as for these areas, the NRRP indicates that treatment of stormwater prior to discharge to land is not required.

In this area the swales, will drain to 1050 mm diameter manholes with domed steel cage inlets 300mm above the invert of the swale. The area immediately surrounding this “scruffy dome” will be constructed of coarse free draining material (with a null or low organic content). An outlet pipe from the dome manhole will convey flow to a soakage field which extends beneath the beginning of the downstream swale (and includes a flushing pit for ease of maintenance) and this pipe will be perforated to ensure spread disposal of runoff to land. The swales have been designed to the methodology outlined in the NZTA Stormwater Treatment Standard for State Highway Infrastructure[84].

A fully kerbed/piped solution was not considered economic nor in keeping with the rural environment which the proposed alignment passes through. Roadside swales also provide water quality treatment.

[84] NZTA Stormwater Treatment Standard for State Highway Infrastructure, May 2010

Swales first flush basin and soak pits

Outside of the pond areas, up to 300 m long swales will collect and treat stormwater runoff from the carriageway. These swales will flow to small basins at the end of each 300 m long swale that will contain a specified organic filter media. Below the organic media, there will be a drainage media, collection system and discharge to ground trench to be constructed in similar manner to that described above for soak pits.

Dry ponds

Adjacent to the CSM1 connection point at Halswell Junction Road, there is potential for elevated groundwater, and a reduced Project cross-section is desirable (due to proximity to SWAP and CSM1 stormwater infrastructure). As per the treatment areas, capture of the first flush and disposal via an organic filter media is proposed. In addition to this, the storage area will be divided by bunds to ensure that any spill from the pond is water which has been retained for the greatest duration. The design percolation rate applied for the dry ponds is 12 mm/hr.

When the groundwater level rises, this has the potential to inflow to the ponds and reduces pond capacity and the ability of the ponds to drain to ground. An intervention strategy is proposed to intercept rising groundwater and to maintain groundwater at or below pond invert level. A drainage system is proposed to allow drainage of groundwater to the Upper Knights Stream by gravity. The intervention strategy will result in no increase to the existing flow rates in the Upper Knights Stream or Halswell River. The outlet to the stream is some 500 m downstream of the Maize Maze pond.

Summary of water quality effects

The NRRP rules are prescriptive with regards to water quality effects. As such, compliance with the rules infers adequate treatment and effects being less than minor. Soakage design on this Project is generally above the water table as per NRRP conditions ensuring that water quality objectives will easily be met for much of the alignment. Where water quality treatment is required, first flush basins will be constructed with organic filter media included in the road drainage system prior to disposal. The residual risks of this approach are:

- inappropriate maintenance of the system leading to reduced percolation rates and flooding;
- contaminant loads being generated in excess of the ability of the organic filter layer to absorb contaminants; or
- bypass of the organic filter layer by inappropriate maintenance or accident.

These risks are addressed through the proposal to develop an Operation and Maintenance Plan for the stormwater system at the detailed design phase.

Overall the treatment proposed is beyond that sought in the NRRP and is considered best practice. Notwithstanding the residual risks outlined above, the effects of the quality of road runoff are considered to be minor.

19.4.2. Surface water quantity

There is potential for rainfall to exceed the minimum percolation rate assumed in the design, which could lead to runoff from limited areas. These flows would have the potential to overtop or exceed the bunding and conveyance mechanisms designed. This would induce spilling of stormwater from the Project into Montgomery's Drain, potentially affecting water quality and quantity in this surface water body, as well as potentially allowing stormwater (including any contaminants) to directly enter groundwater.

The various components of the stormwater and drainage system have been designed for the 100 year ARI event. This includes the conveyance capacity of swales and pipes and the required storage within the disposal system. This standard is required as the vast majority of the stormwater collection and treatment system will be constructed below the existing ground level, limiting the ability to 'spill' out of the system in large events. The 100 year ARI standard required by the NZTA exceeds the requirements of the WWDG (CCC, 2003) and the SDC Code of Practice and the NZ Building Code.

The amount of storage required in the system is a function of runoff (i.e. inflow) and the disposal rate (i.e. outflow), as defined in the hydrological equation (total inflow – total outflow = storage). The maximum amount of storage is typically set by the geometry of the swale or the pond.

Given that the Project runoff is being disposed exclusively to land, effects from the following are not considered as significant, as subsequently outlined:

- intermediate design storm events, e.g. 2, 5, 10 and 50 year ARI events;
- downstream effects;
- receiving waterway sedimentation /erosion; and
- attenuation of flows / hydraulic neutrality.

An assessment of potential flooding effects and risk arising from the Project is provided in Chapter 21, which covers natural hazards. In addition, a Surface Water Modelling assessment is presented in Appendix D to Technical Report 3. This addresses flood risk within the Halswell River catchment associated with the Project's stormwater ponds and confirms that there will be no increase to the existing flow rates in the Upper Knights Stream or Halswell River.

In the event of an over-design rainfall event across the entire alignment, the storage in the system will be filled. Stormwater will fill the intermediate storage and overflow to the next storage basin or swale downstream.

This has potential for large stormwater volumes to accumulate at the lower or sag points in the Project, namely the Maize Maze Pond. Water will flow to the low points in the system, most notably the sag points adjacent to Halswell Junction Road and Weedons Ross Road. There may be potential to spill out of the system to existing overland flow path downstream of the alignment.

The existing railway embankment upstream of the alignment has the potential to block overland flow from upstream and to cause the overland flow to dam and pond. There are only a limited series of small culverts and only one large culvert (750mm diameter) under the rail embankment. The possibility of overtopping the rail embankment is remote. The Project alignment will be another potential overland flow blockage and therefore the design needs to provide for the passing of overland flow paths appropriately. The proposed design for overland flows is discussed in detail in Technical Report 3.

19.4.3. Effects on existing infrastructure

The proposed CSM1 connection ramps have an effect on existing stormwater infrastructure, in particular the pond storage for CSM1. CSM1 infrastructure will be impacted by CSM2, most notably by:

- construction of the southbound off-ramp will partially fill the Lee Pond; and
- construction of the northbound on-ramp will require backfill of approximately one tenth of the CSM1 Mushroom Pond.

Allowances for modifications to the infrastructure have been made in the design of CSM2 to integrate stormwater treatment to ensure the CSM1 system still operates as intended. With the Lee Pond, a proportion of the existing alignment will in future drain to the new Ramp Pond. For the Mushroom Pond, the remaining 90% of the pond volume will be sufficient to service the 30% reduction in catchment area. The on-ramp and CSM1 contributing areas will be diverted to the Maize Maze Pond which will be designed to have the capacity to capture this shortfall.

19.5. Groundwater effects

In terms of groundwater effects, there is potential for elevated groundwater levels to affect the stormwater disposal system and reduce its effectiveness. Runoff from the motorway will be collected and diverted to infiltration structures consisting of grassed swales, ponds and soakpits. Water infiltrating at these structures will percolate downward to the water table where it will cause the underlying groundwater to rise and spread out as a “mound”. The increase in groundwater level has the potential to affect local wells by causing the water levels in the wells to rise, resulting in a decreased lift and lower energy costs for pumping. Consideration of groundwater level rises is also required in relation to existing structures.

Subsurface drains and/or wells are planned to limit the future elevation of the water table beneath the ponds proposed for near the Halswell Junction Road interchange. Wells are planned for a similar purpose for the Robinsons Road overpass where the carriageway of Robinsons Road is to be completed approximately 6.5 m beneath current ground level. The lowering of groundwater levels from beneath the Robinsons Road overpass through pumping for up to 25 days at a time at 100 L/s with discharge to a stockwater race along Robinsons Road and the lowering of groundwater levels via under-drains from beneath the Halswell Junction road ponds with gravity drainage and discharge to Upper Knights Stream are groundwater diversions or takes with the potential to affect existing well water levels.

19.5.1. Water level rises

Before an assessment of effects could be carried out, the maximum high groundwater levels expected after the implementation of the CPWES were calculated using historical data from two long-term ECan monitoring wells together with assessments made by others as part of the consent applications for the CPWES. Maximum high levels of 39.6 mRL (beneath Robinsons Road overpass) and 19.4 mRL (beneath Halswell Junction Road) were calculated. These levels are above the planned roadway at the low point of Robinsons Road overpass and above the bottom of the proposed ponds at Halswell Junction Road.

Robinsons Road overpass

The infiltration of stormwater is predicted to cause small water level rises in the shallow unconfined aquifer. The rise beneath the Robinsons Road overpass is expected to be in the order of 1.5 m directly beneath the structure. When groundwater levels are near their maximum predicted high of 39.6 mRL, this rise could lead to short-term flooding of the local road. The model indicates that with pumping used to maintain the groundwater level below the base of the infiltration structure beneath Robinsons Road, flooding may be eliminated or may only last for a few hours. Without pumping, the roadway would remain flooded for a period which is unable to be specified at this stage, due to the uncertainty of groundwater mounding from the CPWES.

Rises in water levels in Aquifer 1 from the 24-hour, 100 year rainfall event are expected to be much smaller away from the Robinsons Road overpass. A rise (mounding of the water table) of about 25 mm is modelled 100 m from the Robinsons Road overpass infiltration structure with no measurable mounding at distances greater than 250 m. Pumped water would be directed to a stockwater race along Robinsons Road. Field inspection of the stockwater race indicates that the bottom is coated with clays and fines that have settled out from the water carried by the race. This material would limit seepage such that the additional water introduced to the stockwater race is unlikely to result in a significant increase in seepage from the race to the groundwater system.

As an alternative to groundwater lowering, the local road would be allowed to flood for periods of time, in consultation with the road controlling authority. In this situation, diversions for local traffic would be put in place.

Mounding would be offset by groundwater abstraction well pumping prior to stormwater infiltration. Any pumping would likely to be started when groundwater levels rose to within 1 m of the base of the infiltration trench below Robinson Road and would be directed to the stockwater race along Robinsons Road.

Halswell Junction Road Interchange and CSM2

Water level rises beneath the Halswell Junction Road interchange are expected to be small because of the under-drain system planned for construction beneath the Maize Maze, and Ramp ponds and the Owaka Basin. The relatively low hydraulic conductivity of the surficial deposits beneath Halswell Junction Road will limit the ability of the ponds to infiltrate stored stormwater to the underlying Aquifer 1. As such the primary purpose of the ponds will be storage to limit peak discharge.

The results of the modelling of infiltration indicate the groundwater beneath the proposed ponds would rise by 1.4 m to 2.6 m in the absence of an under-drain. The modelling also indicates that it may take up to two weeks for the pond to fully drain without intervention in the form of pumping, gravity drainage or an under-drain system. Such rises under high water level conditions would cause groundwater to rise above the bases of the ponds, reducing storage capacity and may cause lifting of pond liners (where these occur). The under-drain system proposed to limit the maximum water level rises beneath the Project ponds will both assist in limiting mounding in Aquifer 1, maintain the full storage function of the ponds, and prevent any increase in flow rates in the Upper Knights Stream and the Halswell River.

Summary

Seasonal variations in groundwater levels recorded in ECan wells range from 2 m to 6 m. Such variations would mask local mounding effects. The effects of mounding beneath the facilities on groundwater are therefore considered to be less than minor.

19.5.2. Operational dewatering

Pumping at the Robinsons Road overpass and gravity drainage from the under-drains for the proposed Project ponds at Halswell Junction Road will only occur when groundwater levels are 1.3 to 2.5 m higher than they have been in the past. The frequency and duration of pumping cannot be accurately predicted using the available data. However, statistically, the maximum groundwater level is predicted to rise up to within 1 m of the low point of Robinsons Road (39.5 mRL) less than 5 % of the time after the CPWES is in full operation and more likely closer to 1% of the time. Because of this uncertainty, allowing Robinsons Road to flood occasionally may be a viable alternative to the pumping and water level control system and is proposed as an alternative option.

Effects of operational dewatering on other groundwater users

The removal of groundwater from the Project ponds at Halswell Junction Road by gravity drainage (estimated to produce less than 50L/s) through a manifold system would not affect any existing groundwater user because it would not lower groundwater below current levels. Only higher groundwater levels that might occur in the future would be lowered through this self-limiting system. Future groundwater users would also not be limited by this set up. The drawdown “cone of depression" of the water table induced by any well pumping hard enough, would lower the water levels beneath the ponds meaning that the gravity drainage would cease and the aquifer would respond as if the under-drains or dewatering wells did not exist.

When the Robinsons Road overpass wells are pumped at a total of 100 L/s to limit the water level rise, the drawdown effects are estimated to be a drawdown of 10 mm at a distance of 1 km and about 1 m at a distance of 100 m from Robinsons Road overpass. Nearby wells would also not be affected because if such a well was to pump at a rate high enough to lower levels at Robinsons Road, pumping from the Robinsons Road overpass system would cease and allow the nearby well to pump at its consented rate.

Effects of dewatering on surface water

Surface water will be little affected as the discharge from the gravity drainage system will be directed to Upper Knights Stream, its local discharge point without the dewatering system.

Pumping from beneath the Robinsons Road overpass facility would be discharged directly to the adjacent stock water race, with minimal effects.

Summary

The effects of water level limitation at the Robinsons Road overpass and Halswell Junction Road facilities are considered to be less than minor. The effects of the reduced water levels beneath Robinsons Road overpass and Halswell Junction Road under high water conditions are considered to be less than minor. These systems will only be operated occasionally when water levels are near their maxima and will not lower groundwater levels below those that occur today or have occurred in the past.

19.5.3. Groundwater quality

An assessment of effects of stormwater discharge on groundwater quality has been undertaken and is contained within Appendix G of Technical Report 3.

This assessment has modelled the effect on groundwater quality of stormwater contaminants produced from road runoff during operation of the Project (i.e. a contaminant modelling assessment). The model used to assess the effects comprised a series of Microsoft Excel worksheets developed by the UK Environment Agency. These worksheets allow contaminants to be modelled as they migrate from the soil source zone to groundwater and then within groundwater to a selected point where the groundwater is utilised or discharges into a sensitive environment. The contaminants modelled were copper, zinc and the polycyclic aromatic hydrocarbons (PAH), pyrene and fluoranthene.

The estimated concentrations of copper and zinc in stormwater are less than their NZ Drinking Water Standard values. Therefore, copper and zinc in stormwater discharged from the proposed alignment pose low risk to groundwater used for potable supply.

Risk assessment of pyrene and fluoranthene has indicated that when dilution in groundwater beneath the alignment and attenuation along the groundwater flow path is considered, these contaminants pose low risk to groundwater used for potable supply. This is valid for wells that are located 30m or more from the designation boundary. The contaminant modelling assessment identified 17 wells within 30m of the study boundary that may be affected by stormwater discharge. The study boundary within the Assessment of Effects on Groundwater Quality (Appendix G of Technical Report 3) includes the area between the western rear access road and Main South Road where the wells may be located within the designation footprint, within 30 m of the designation boundary and outside a 30m buffer.

Appendix 3 of this AEE includes a list of 47 wells potentially affected by stormwater discharges and the Project (i.e. those wells located within 30m of the designation boundary and those wells located within the designation footprint). These wells (if active) may require relocation clear of the Project designation footprint and areas potentially affected by stormwater discharges. Bores that are not used would not need to be relocated. Bores listed as being within the designation may be decommissioned and/or relocated following specific consultation on this matter with affected land owners. The bores listed as outside of the designation, are those located within 30m of the designation boundary and potentially affected in terms of the contaminant modelling work carried out, although, it is noted that this modelling is conservative in terms of identifying actual effects. These bores outside of the designation may be decommissioned and a new bore established, if required by the landowner, in an alternative location. Only three of the bores, M36/2231, M36/3875 and M36/4353, are associated with irrigation consents, the remainder are assumed to relate to permitted activity water takes, or are not used.

19.6. Land use activities affecting water

19.6.1. Installation of outfall structure to Upper Knights Stream

A 300 mm diameter outlet pipe will be installed in Upper Knights Stream (at the end of the existing John Paterson Drive) to discharge the gravity drainage groundwater from beneath the Maize Maze and Ramp Ponds located at the Halswell Junction Road interchange. There will be no works in water for the installation, as they can be carried out when the stream is dry. Sediment and erosion control measures will be implemented in accordance with the erosion and sediment control plan. Scour protection will be installed in a way that does not reduce the carrying capacity of the stream. At this location the stream is typically a dry semi-vegetated channel and it will be reinstated to this upon completion of the stream bed works. As the works will be carried out in dry conditions, and vegetation reinstated, the effects on aquatic values will be less than minor.

The outlet and its installation will have less than minor effects on amenity, flooding, erosion and water quality.

19.6.2. Former stream bed reclamation

The realignment of John Paterson Drive affects an old stream bed identified in the NRRP which has been infilled completely and is currently farmed. The water appears to have been diverted in the past, to the nearby land drainage race, which will be realigned slightly to allow for the construction of the extension to John Paterson Drive.

The proposed local road extension will have no effect on the former stream bed, given the nature of the environment affected by this work.

19.6.3. Effects of storage of hazardous substances on soil and groundwater quality

Approximately 5,000 litres of fuel may be stored on site at any one time. Inadequate handling and storage of fuel, oil and hazardous substances may lead to localised spills and leakages and potential contamination of the underlying soils and aquifer.

To manage this risk, it is important that the CEMP describes measures to avoid, remedy or mitigate the effects of the use and storage of hazardous substances during construction of the project and the transport, disposal and tracking of materials taken away. The CEMP will include details on the types and volumes of substances stored, measures to minimise risk of spills and spill containment equipment and procedures, procedures to identify the sources of leaks and prevent recurrence. With these measures in place, the effect of the storage and use on soil and water quality will be less than minor.

19.6.4. Effects of excavation and deposition on groundwater quality and aquifer pressure

The longitudinal sections included in the Drainage Details in Volume 5 of the application documents identifies areas where the interception of groundwater may occur. The sections show an assumed high water level which includes the contribution from the CPWES. On the basis of these levels it would be prudent to carry out the excavation works at the eastern end of the alignment and at Robinsons Road before the full implementation of the CPWES, if possible. Alternatively works in these areas may be carried out in summer or other times of lower water levels. Piling activities are also likely to intercept groundwater. The longitudinal sections highlight the areas where the contractor would need to be aware of groundwater levels to implement methods to protect groundwater.

Interception of aquifers in piling or other excavation work might result in floating of piles, loss of pressure in the artesian aquifer or mixing of water between aquifers if depressurisation of the aquifers occurs. Interception of artesian aquifers in excavations that is uncontrolled might result in piping of sands into the excavation or heave of silts; require excessive pumping, drawdown and potential ground settlement beyond the excavation.

Mitigation measures are proposed to address the effects of excavation on groundwater quality and pressure. Where artesian aquifer is encountered, or where the unanticipated interception of large non-artesian inflow enters an excavation, an Accidental Aquifer Interception Management

Plan (AAIMP) will be implemented. A Draft AAIMP (SEMP006) is attached in Volume 4 of the application documents, which contains the draft management plans for the Project. The effects on aquifer pressure can be mitigated through appropriate sealing of any interceptions. These mitigation measures are included in the Draft AAIMP.

The Draft AAIMP provides an overall framework for the control of accidentally intercepted groundwater. It outlines the construction, operation and implementation steps to be taken to control, stop and seal groundwater flow during construction. With the measures proposed in the AAIMP the effect of excavation on aquifer pressure will be minor.

Other mitigation measures are proposed for typical interception works in the unconfined water table aquifer. This includes measures to minimise the seepage of groundwater into the excavation, management of water within the excavation and / or measures to reduce the volume of water reaching the excavation.

Where the rate of seepage is low, water can be managed in the excavation by pumping. This water may need to be pumped to the sediment ponds before being discharged, depending on levels of sedimentation.

Reducing the seepage reduces the amount of sediment-laden water that needs to be managed during works and means that excavation works can proceed more easily. While not expected to be necessary for this Project if construction is prior to future predicted groundwater level increases, dewatering to lower the surrounding water table may potentially be employed to reduce seepage to an excavation. This would allow clean and sediment-laden water to be kept separate reducing the need for sediment control measures. Dewatering may be carried out via bores or linear dewatering using spears with the method dependant on the aquifer characteristics.

Groundwater quality could also be at risk if excavations expose groundwater and contaminants are allowed to enter the excavations. The presence of contaminants on the site is predominantly limited to vehicle fuels and soil materials. Materials used to seal a breach of the confining layer are from the excavations or the materials outlined in the Draft AAIMP.

Best practicable measures will be adopted to prevent the discharge of sediment and contaminants into excavated land including the installation and maintenance of sediment and erosion control measures, stabilising or re-grassing. The storage of fuel and refuelling of machinery will not be carried out within 50m of excavations and measures will be taken to prevent oil and fuel leaks from machinery.

Deposition of material will be the result of creating embankments, stormwater ponds and swales. The deposition will not result in the limitation of future land uses in terms of soil quality. Deposited material will consist of clean fill materials only.

19.6.5. Effects of well construction on groundwater quality

Bores will be drilled outside the zone of influence to replace wells that may be affected by the proposal. Groundwater may become contaminated by drilling of bores for water or geotechnical exploration, or as a result of open, uncased, old or damaged bores or wells. Bores and wells therefore need to be constructed and managed to acceptable standards to avoid, remedy or mitigate adverse effects on groundwater quality.

Well construction will be carried out to limit the movement of water between water-bearing layers, sealing any other layers encountered during drilling. A concrete pad surrounding the well headworks will be installed with each well to prevent the ingress of contaminants into the underlying groundwater.

19.7. Erosion and sediment control during construction

Consideration has been given to erosion and sediment control during the construction of the Project. The management of stormwater during construction expressly requires resource consent (in relation to Rule WQL6 of the NRRP) due to the large areas of soil which will be exposed.

The options for disposal are limited by the absence of suitable surface water disposal points, as regular disposal to stockwater races is not permitted by the SDC. Key issues for this site are:

- control of stormwater and isolating runoff from the stockwater network;
- separating clean from dirty water;
- protecting adjacent landowners from surface flows;
- minimise sediment leaving the site; and
- disposal to land.

Further details are provided in the Draft CEMP and the Draft Erosion and Sediment Control Plan ("ESCP" or SEMP002) which has been prepared in accordance with the ECan Erosion and Sediment Control Guidelines, 2007 and the NZTA Stormwater Treatment Standard for State Highway Infrastructure, May 2010. The CEMP and the ESCP are contained within Volume 4 of the application documents. The temporary erosion and sediment control measures will be designed to discharge to land for most rainfall events. The design standards used in the Draft ESCP are as follows:

- Clean water diversions – these are designed to cater for the 10 minute - 5% AEP event (1:20 year Return period event) and cater for overland flow only. Overflows may occur above this event and will discharge into the works, until such time as the Project siphons are installed. Siphons will be constructed early in the construction period to mitigate this risk.
- Sediment retention ponds - designed to cater for the 10 hour - 20% AEP event (1:5 year return period event).
- Overflow spillways from the sediment retention ponds will be designed to cater for the 10 minute 2% AEP event (1:50 year return period event flow). As there are no

watercourses available to discharge overflows from the ponds, a site specific assessment will be carried out prior to construction in accordance with the ECan Erosion & Sediment Control Guideline. This will follow the following general principles:

  - Size sediment retention ponds to cater for a larger storm event;
  - Provide additional bunding at edge of site to prevent flood water from leaving the construction site;
  - Adjust and monitor site operations to reduce flow to sediment retention ponds (i.e. reduce / stop pumping to ponds, stop working in inundated areas);
  - Provide additional soakage areas.

- Decanting earth bunds (mainline carriageway) - designed to cater for the 10 Hour - 20% AEP Event. As the road is in cut along the carriageway edges, any overflows from the decanting earth bunds will be contained within the road corridor.

When the above measures are exceeded and the erosion and sediment control are inundated by a large storm event, the discharges may reach surface water. The locations where this may occur are similar to those illustrated in Figure 51, with the exception of the location labelled “CSM2-F2”. Further detail on these locations and the nature of the potential construction discharge is provided in the Draft ESCP (SEMP002).

The risk of a failure of the erosion and sediment control measures leading to discharge of sediment laden water to the nearby stockwater races is considered to be low, given the flat topography. It is likely that the contractor would be able to remediate a failure within the Project footprint, in order to avoid discharging sediment laden water to surface water.

Any construction discharges to surface water associated with a failure of an erosion and sediment control device will potentially contain high levels of suspended sediment, potentially affecting water quality and aquatic habitat. Any discharge to surface water would only occur during a major storm event, when the SDC typically shut off the stockwater races, to allow them to perform a land drainage function anyway. Because the races are likely to be carrying runoff and sediment from throughout the district, the effects on the surface water body from any Project discharge, will be minor. Aquatic habitat species within the stockwater races are tolerant of sedimentation and increased turbidity so on-going adverse effects are not anticipated in this situation. Further discussion on the potential effects on aquatic values is provided in Chapter 20.

19.8. Mitigation

The design standard applied in sizing the stormwater infrastructure is a 100 year return period. This is the primary tool used to mitigate the effects of the increased runoff generated by the Project and reduce the residual risks of spilling from the highway drainage system or potential failure of the disposal system.

In addition, the proposed disposal system is dispersed (regular soak pits as opposed to large disposal facilities), so failure of one component will not result in catastrophic failure of the whole system. This provides some inherent redundancy in the system and allows a more passive maintenance programme whereby localised flooding can be used to identify failure in soakage devices (rather than by regular testing).

In order to mitigate for high groundwater, a series of groundwater inception trenches and/or groundwater inception bores are proposed to be connected to a gravity drainage system that will discharge to the Upper Knights Stream. This system will ensure that future groundwater level rises will not impact on the capacity or performance of these ponds.

A number of other key components of the highway drainage design have been implemented to mitigate the effects on the receiving environment, including:

- pumping of stormwater or groundwater has been eliminated from the permanent works design to ensure reliability of the system and lowering residual risk. The notable exception is the proposed pumping at Robinsons Road;
- the placement of the proposed soakage devices has been to maximise the distance between the devices and any stockwater races or overland flow siphons; and
- additional soakage devices and larger soakage areas have been proposed on the upstream side of the Project to facilitate the disposal of any overland flows which may overtop the stormwater bund protecting the highway drainage system.

The risk of groundwater levels rising above the maximum predicted levels can be reduced by a groundwater intervention strategy to intercept the groundwater and to discharge this groundwater away from the facilities and outside the zone of influence. This groundwater level intervention can be achieved through design at Robinsons Road overpass and the Halswell Junction Road ponds.

Technical Report 3 provides recommendations for further mitigation through proposed consent conditions and other measures. These are relevant to the consideration of the regional consent applications and are summarised below.

Table 36: Mitigation recommended in Technical Report 3

Aspect	Commentary	Recommendation
Soak Pits	The soak pits form an essential element for the disposal of stormwater along the route. The on-going operation of the soak pits is an essential element in the design, as there is no alternative disposal mechanism. The design is to achieve an adequate level of redundancy to ensure that progressive failure of individual elements in the Project design does not affect the users of the road system or cause negative off-corridor effects, such as additional surface flooding in the Halswell catchment.	Development of field testing programme to confirm soakage rates of receiving ground should the detailed design vary from rates specified in Technical Report 3. Further full scale field testing at critical locations including sag points. Drafting an Operation and Maintenance Plan during detailed design for soakage devices.
Stormwater Treatment	The first flush basins rely on organic filter media to achieve the water quality objectives. These devices have the potential to concentrate contaminants and sediments. In order to ensure that they perform adequately a monitoring programme is proposed.	Specific soil parameters of first flush filter media replacing percolation rates are set in NRRP. Monitoring of soil contamination at disposal sites. Conditions on replacement of soakage filtration media. Monitoring of percolation rates through soil media to ensure these are similar to design rates.
Stockwater Races	The stockwater races form two distinct functions: a) as a conveyance mechanism for stockwater and irrigation and b) as a land drainage function during extreme weather conditions. The on-going operation of the stockwater races are an essential element in the Project design. The design is to achieve an adequate level of redundancy to ensure that individual elements in the Project design do not affect the stockwater race functions as set out above.	Considering the nine stockwater races during the detailed design stage covering a) on-going operation of the supply of water during and post construction, b) passage of flood and land drainage function of the races, c) any deviation or alternative route, d) any consequential effect of spill from storm events, e) the construction of deviations to be completed off line before the new deviation is made live, f) limiting the time and occurrence of over pumping to emergency and limited period occasions (e.g. tie ins).

Aspect	Commentary	Recommendation
Overland Flow Paths	The overland flow paths form an essential element for the passage of stormwater across the route. The on-going operation of the overland design is an essential element in the design, as there is no alternative. The design is to achieve an adequate level of redundancy to ensure that progressive failure of individual elements in the Project design does not affect the users of the road system or cause negative off corridor effects.	Consideration of the major overland flow paths during detailed design covering a) the assessment of discharge beyond the Project area, b) how flow paths will be managed during construction, c) operation and maintenance of the siphon structure. Conditions on how additional flow paths identified following detailed topographical survey will be dealt with and how additional crossing points identified during the detailed design will be managed. Adherence to the design criteria outlined in Technical Report 3 for designing alternative locations for the crossing points under the Project alignment, potentially including a) a full assessment of the upstream and downstream flooding, b) ponding and effects of discharge of concentrated flow on property and habitable floor levels downstream of the Project area.

Aspect	Commentary	Recommendation
Owaka Basin, pond adjacent to Meadow Mushrooms and Maize Maze Pond	The Maize Maze Pond and its associated disposal to land system form an essential element for the disposal of stormwater adjacent to the CSM1 - CSM2 - Halswell Junction Area. The on-going operation of the soakage to land and protection of groundwater quality is an essential element in the design. The design is to achieve an adequate level of redundancy to ensure that progressive failure of individual elements in the soakage system does not affect the users of the Project system or cause negative off corridor effects such as additional surface flooding in the Halswell catchment during events of lesser magnitude than the critical 100 year storm event.	Development of an Operations and Maintenance Plan to consider the normal and emergency flow of all the SW pond structures in the vicinity. Inclusion of a liner system that prevents the direct connection of surface water to land in the forebay section of the pond. The design of the pond shall include a) an ability to receive and store the entire 24 hour 100 year storm runoff from the Project, b) groundwater intervention to maintain groundwater equilibrium and maintain current flow rates in Upper Knights Stream and Halswell River, c) an ability to draw down the level of the pond level following a large rain event and discharge this flow to the Upper Knights Drain or Montgomery's Drain. A process for the controlled release of water from the Maize Maze Pond to the Halswell River system (including discussion with the ECan and the CCC).
Robinsons Road	The potential for Robinsons Road overpass to be inundated by groundwater has been identified with the predicted CPWES in place. Given the uncertainties with the CPWES implementation and effects the above conditions are designed to allow the uncertainties to be mitigated with future action.	On-going monitoring of groundwater levels at the site undertaken to establish the appropriate mitigation for this. Development of an Operation and Maintenance Plan for any pumping and disposal system.

Aspect	Commentary	Recommendation
Erosion and Sediment Control	Erosion and Sediment Control form an essential element for the protection of the environment along the route. The on-going operation of the soakage design is an essential element in the design as there is no alternative. The design is to achieve an adequate level of redundancy to ensure that progressive failure of individual elements in the Project design does not affect the users of the road system or cause negative off corridor effects such as additional surface flooding in the Halswell catchment.	Development of an Erosion and Sediment Control Plan for each work section along the Project covering a) clean and clear water diversions, b) diversion drains for sediment laden runoff, c) use of permanent swales and the ability to rehabilitate the swale to its final purpose during the construction process, e) specific disposal to land soak pits which are not to form part of the final soak pit system, f) methods to prevent discharge of sediment laden water off site or to land, g) cover the issues addressed in other plans such as overland flow path construction, stockwater race construction, existing bores/wells and the works required at each intersection, h) on-going maintenance requirements, i) disestablishment criteria

19.9. Conclusion

The NZTA accepts the recommended mitigation set out above and the means by which it proposes to incorporate these matters into the Project are outlined in Chapter 27 – Mitigation and Monitoring.

The Project design, this assessment and the recommended conditions of consent appropriately provide for the avoidance and mitigation of any adverse effects of the Project on water resources.