IAN GUNN
ENVIRONMENTAL ENGINEERING CONSULTANT
FIPENZ
P.O. Box 17-368, Greenlane, Auckland 1546, NZ
PH: 64-9-579 2327 FAX: 64-9-579 2324
E-mail: i.gunn@auckland.ac.nz

HENLEY DOWNS DEVELOPMENT, QUEENSTOWN
PROPOSED PLAN CHANGE

WASTEWATER MANAGEMENT REVIEW

Report For: RCL Queenstown Ltd
C/- John Edmonds & Associates Ltd
PO Box 95
QUEENSTOWN 9348

DRAFT v4

Date: 17 December 2012

1.0 INTRODUCTION

1.1 Background

The Henley Downs development area is currently zoned under the Queenstown Lakes District Plan for residential and other land use activities and is located directly to the north of Jacks Point residential areas and golf course. A plan change proposal is being prepared for RCL Queenstown Ltd (RCL) which aims at increasing the dwelling density and incorporating additional land use activities within the zoned area. This report addresses the wastewater servicing options for the plan change proposal.

1.2 Site Information

John Edmonds & Associates Ltd [JEA] has provided detailed information [Ref. 1] on the proposed plan change elements showing locations of:

- residential zoned area;
- proposed village area;
- potential education locations;
- service activity area;
- low intensity use area (training and recreation facilities);
- rural living area;
- wastewater effluent potential land application area; and
- existing Jacks Point wastewater treatment and irrigation field areas.

A range of additional documentation has been provided by JEA including:

- Proposed Plan Change site plan [Ref. 2];
- Master Development Plans for the Plan Change (showing residential lot layouts along with the proposed village area and areas of future undefined land uses which could be residential or educational); and
- Soil map for the Jacks Point and Henley Downs area [Ref. 3].

Documentation related to Jacks Point wastewater reporting held on file by the writer has also been consulted including:

- Landcare soils evaluation for Jacks Point [Ref. 4];
- Glasson Potts Fowler (GPF) soils evaluation for wastewater application [Ref. 5];

- GPF wastewater servicing proposals for Jacks Point [Ref. 6]; and
- Innoflow Technologies Ltd (Innoflow) case study for Jacks Point wastewater management. [Ref. 7].

A site visit and briefing meeting was undertaken on 17 October during which the development master plans were discussed, geological reports provided, the Jacks Point wastewater treatment and irrigation field locations were visited, and the Henley Downs development areas overviewed. In addition, a soil examination excavation was dug in a field within the "low intensity use area" of the zoning map just to the north of the proposed residential area.

2.0 ENVIRONMENTAL OBJECTIVES

Given the location of the proposed development within the catchment of Lake Wakatipu and the high value placed on both lake water quality and the natural environment of the area, RCL are seeking a wastewater management solution that will deliver the highest environmental performance consistent with best-available-technology. The proposed solution has also to be sensitive to cultural (tangata whenua) objectives. For these reasons the approach to wastewater management is to minimise the quantity of effluent residuals discharged into the environment by use of high performance wastewater treatment followed by land application via drip irrigation of the resulting high quality effluent for further in-soil treatment and uptake by vegetation.

3.0 WASTEWATER FLOW QUANTITIES

The original zoning for the main residential area was based on a dwelling density of 10 to 12 dwellings per hectare and a total of 561 dwellings. The plan change proposal is to increase the dwelling density to around 15 dwellings per hectare. The Master Development Plan (Revision A) of 4 September 2012 provided during the site visit shows the majority of lot sizes in the range 600-800m^2. When the residential area requirements are included with the proposed new village area and educational and other development, the allowance for wastewater flow determination as at 17 October was to be based on 900 dwellings.

Subsequently, following an initial review of wastewater servicing options and the availability of land for treated effluent irrigation, a review of development options by JEA has asked for an assessment of servicing requirements for up to 1,750 dwelling equivalents.

For Jacks Point GPF designed for 5 persons per dwelling at 190 L/person/day, total flow per dwelling of 950 L per day [Ref. 6]. The installed system provided by Innoflow [Ref. 7] was based on 985 L/dwelling/day.

Adopting a design flow based on 5 persons per dwelling at 200 L/person/day, then for 1,750 dwellings the total flow for treatment and land application would be 1,750 m^3/day.

4.0 SITE and SOIL CONDITIONS

The Henley Downs residential zoned area occupies sloping topography from the east down to the flats of the central plain area north of the Jacks Point development. The lands on which both developments are located consist of four main soil types. These are described in relation to Jacks Point [Ref. 4 and 5] as follows:

- Wanaka soils – cover the greatest area and are typically flat to gently sloping soils, which are formed in glacial deposits;
- Pigburn soils – occupy the second greatest area and are typically characterised by being in valley floors;

- Frankton soils – are poorly drained soils located in the central valley and also north of the Henley Downs zoned area; and
- Shotover soils – located to the immediate north of the Henley Downs zoned area.

Characteristics of the Wanaka, Pigburn and Frankton soils are detailed in Refs 4 and 5 with a map of the location of all soil types provided in Figure 7 of Ref. 3. For characteristics of the Shotover soils the National Soils Database has been consulted [Ref. 8]. The loamy silt character of the Shotover soils was confirmed by an exploratory excavation and soil texture assessment (feel test) undertaken during the site visit.

The suitability of the Wanaka, Pigburn and Frankton soils for treated effluent application has been assessed by GPF [Ref. 6] as per the table below. The suitability of Shotover soils has been interpreted from Refs 8 and 9 and the site visit examination.

Soil Type	Characteristics	Irrigation Suitability	Recommended DIR mm/d	Information Source
Wanaka	Sandy loam topsoil overlying loamy gravel till; free draining	• Subsoil infiltration limitation • Year round irrigation possible	Winter: 6mm/d Summer: 18mm/d	Refs 1 and 3
Pigburn	Sandy loam topsoil over massive sandy loam. Deep rooting and high water holding capacity; free draining	• Subsoil infiltration limitation • Year round irrigation possible	Winter: 12mm/d Summer: 18mm/d	Refs 1 and 3
Frankton	Deep loamy silts in low areas; poorly drained with persistent high water tables in winter; subsoil probably dispersive; risk of winter wetness unless drained.	• Subsoil infiltration limitation • Should not be used for irrigation in winter	Winter: 0mm/d Summer: 6mm/d	Refs 1 and 3
Shotover	Loamy silt (slightly sticky) overlying loamy sand at 760 mm. (Loess covered alluvial fan areas.)	• Potential for year round irrigation at low application rates	To be determined by detailed soil investigation	Refs 8 and 9 (plus site visit examination)
DIR – Design Irrigation Rate mm/day (equals litres per square metre per day)				

In providing for wastewater management for Jacks Point, GPF [Ref. 6] has utilised the Pigburn soils as the best available areas for siting the drip irrigation fields for treated effluent. The locations of the installed irrigation fields for Jacks Point are shown as areas 1 and 2 on the attached aerial location map (based on Ref. 2), "Henley Downs Plan Change – Potential Irrigation Field Locations". A third treatment unit and irrigation field system for Jacks Point is located at the north west edge of Jacks Point, but is not shown on the attached map.

5.0 WASTEWATER SERVICING OPTIONS for HENLEY DOWNS

5.1 Servicing Concept

Two servicing concepts are viable for the proposed development.

Concept A: Comprises on-lot advanced septic tank units (incorporating effluent outlet filter) and STEP (septic tank effluent pumping) conveyance of primary treated flows via to a central treatment plant for secondary treatment prior to effluent drip irrigation. This concept has been utilised for Jacks Point, with the STEP system involving a septic tank and pump unit on each property. For the high density layout of the proposed residential area (lot areas of 600-800m^2) at Henley Downs a cluster STEP system is appropriate in which each STEP pump station handles inflow from several on-lot septic tanks. The septic tanks have to be periodically pumped out. Flow from the STEP units

would be transferred via small bore pressure sewer to a centralised secondary treatment plant to handle full flow from the 1,750 dwelling development.

Concept B: Comprises a modified conventional sewerage system to collect full wastewater flow from individual lots and convey via gravity to a central treatment plant. The modified sewers involve smaller diameter flexible pipe systems with limited manholes compared to conventional gravity sewer systems. No pre-treatment thus takes place on each property (as for Concept A above). One or more pumping stations may be required depending on the development layout. The centralised treatment plant provides full primary-secondary effluent treatment to a standard suitable for drip irrigation.

5.2 Wastewater Treatment

Options for wastewater treatment under each of Concepts A and B above are as follows:

Option One (Servicing Concept A): Only secondary treatment is required as solids are retained for primary treatment in the on-lot septic tanks. With the flow volume of primary treated wastewater from 1,750 dwellings comprising 1,750m^3/day, the use of AdvanTex AX-100 modules as for the Innoflow system at Jacks Point is best replaced by the AdvanTex AX-MAX modular units sized to accommodate the larger flow volume from the overall development. Being modular the AX-MAX system provides flexibility in dealing with seasonal occupancy in the same manner as the AX-100 system. The AX-MAX system can be configured as required to meet nutrient and bacterial standards for effluent discharge quality.

Option Two (Servicing Concept B): Full primary and secondary treatment is required. The AdvanTex AX-MAX units as for Option One can be configured and operated to handle full strength domestic wastewater flows while still achieving the required effluent quality (including nutrient and bacterial rstandards). Solids settlement, digestion and consolidation take place within the AX-MAX system.

Option Three (Servicing Concept B): Full primary and secondary treatment is required. A sequencing bach reactor (SBR) aeration treatment system would provide fully aerobic secondary treatment of solids and liquids, and can be configured as required to remove intestinal bacteria (via tertiary treatment disinfection) and reduce nutrients such as nitrates and phosphates (via quaternary treatment nutrient reduction).

Partially treated sludge solids are collected from individual septic tanks under Option One and from the AX-MAX units from Option Two, and would need to be transferred for final treatment at a municipal treatment plant facility. Residual aerobically digested humus solids from Option Three could be dewatered on site for use in landscaping around the development area.

Option Three is likely to require a lower footprint than Options One and Two. However, the main disadvantage of Option Three is the high energy requirement to achieve aerobic treatment of both solids and liquids in the full wastewater flow.

[Note: In wastewater treatment terminology there are four degrees of effluent treatment. "Primary treatment" refers to basic settling and solids retention such as achieved by a septic tank. This has to incorporate separate sludge management facilities. "Secondary treatment" refers to the aerobic biological processes provided by activated sludge aeration plants, and sand filter or textile aerobic packed bed reactors which usually follow "primary treatment". Some processes (such as SBR) utilise full flow "secondary treatment" in which all solids are treated aerobically. "Tertiary treatment" relates to the use of disinfection processes to remove human intestinal micro-organisms following secondary treatment. UV is accepted as the most environmentally acceptable disinfection process. "Quaternary treatment" relates to nutrient reduction processes.**]**

Given that the Jacks Point resource consent for discharge of treated effluent to land requires stringent controls on bacteria, nitrogen and phosphorus levels [Ref. 10] then the Henley Downs treatment plant is likely to require high intensity tertiary and quaternary treatment stages.

5.3 Land Application of Treated Effluent

(a) General: The high quality treated effluent from this development can be returned to the environment through drip or spray irrigation lines for subsoil infiltration and plant evapo-transpiration. Environmental impact is confined mainly to the soil within a metre or so depth below the distribution lines. Bacteria would be adsorbed onto soil surfaces to be retained and die off. A substantial portion of nutrients would be taken up by plant growth, with rainwater infiltration and dispersion at depth into the groundwater extensively diluting any remaining nutrient. Groundwater would disperse much of such highly diluted effluent residuals to the north of the area away from the lake. Harvesting of plant growth can be used if need be to remove nutrients from the irrigation fields and limit their potential impact on groundwater.

The matter of effluent quality for land irrigation will be subject to review during the discharge consent application procedures to be considered in due course by the Otago Regional Council. At that time the results of a detailed environmental assessment will be available to confirm the extent of discharge permit conditions.

(b) Land irrigation options: Drip irrigation of highly treated effluent as for Jacks Point is an appropriate method of land application of effluent for Henley Downs.

The other option for land application is spray irrigation of disinfected effluent which could be accomplished by either:

(a) Low level spray heads distributing to pasture for cut and carry removal of nutrient rich biomass (grass harvesting) in order to limit nutrient seepages to groundwater; or
(b) High level spray heads distributing to a tree covered landscape such as a eucalyptus plantation which can be coppiced to remove biomass and thus export nutrient material from the catchment.

Depending on the nitrogen reduction requirements for discharge to land, this can be provided for by removal in the AX-MAX or SBR processes before irrigation as well as via harvesting of planted crops (grass or trees) in the irrigation areas.

5.4 Assessment of Potential Land Application (Irrigation Field) Areas

The proposed effluent land application area identified in the plan change proposals [Ref. 1] on Henley Downs farmland to the north of the residential zone consists of Frankton soils. GPF has identified these soils [Ref. 5] as having significant limitations for effluent irrigation. Shotover soils cover the larger area of farmland immediately bordering the north boundary of the proposed residential zone, but these were not discussed in the earlier reports on Jacks Point. However the National Soils Database [Ref. 8] provides adequate details of the Shotover soils in comparing these with the other soil types in Jacks Point.

Subsequently, in discussions with JEA, it has been decided to evaluate the potential use of lands for irrigation fields including;

- the Wanaka soil areas in grazing lands immediately to the west of the Henley Downs;
- the proposed plan change land areas for the Henley Downs; and
- extending the current Jacks Point irrigation areas;

The best available locations for irrigation in the Jacks Point/Henley Downs area are the Pigburn soils. Wanaka soils would be second priority and Shotover soils third. The tables below compare

the GPF recommended design irrigation rates [Ref. 5] for the Pigburn soils (on which the Jacks Point irrigation areas are located) with potential irrigation requirements on both Wanaka and Shotover soil locations. The areas cited in the tables are shown on the attached location map, "Henley Downs Plan Change – Potential Irrigation Field Locations".

Existing Irrigation Areas – Jacks Point

Area	Soil Type	DIR Potential	DIR [Installed System]	Net Area	Irrigation Field Area	Capacity [No. of Dwellings Served]
1	Pigburn	Winter: 12mm/d Summer: 18mm/d	12mm/day	9.7ha	2.74ha (3.30ha)	334 (Village)
2	Pigburn	Winter: 12mm/d Summer: 18mm/d	12mm/day	2.1ha	0.86ha	105

Potential Irrigation Areas – Jacks Point and Henley Downs

Area	Soil Type	DIR Potential	DIR [Potential System]	Net Area	Irrigation Field Area [Potential]	Capacity [No. of Dwellings Served]
A	Frankton (60%) Shotover (30%)	Winter: 0mm/d Summer: 6mm/d	Not recommended	21.2ha	(4.8ha)	(190)
B	Shotover	To be confirmed by detailed soil investigations	4mm/day [estimated]	28.5ha	21.3ha	850
C	Pigburn (85%) Wanaka (15%)	Winter: 12mm/d Summer: 18mm/d	8mm/day	9.4ha	5.7ha	450
D	Wanaka	Winter: 6mm/d Summer: 18mm/d	6mm/day	8.7ha	6.5ha	390
E	Pigburn	Winter: 12mm/d Summer: 18mm/d	8mm/day	4.6ha	3.4ha	270
F	Pigburn	Winter: 12mm/d Summer: 18mm/d	8mm/day	4.6ha	2.8ha	225
G	Wanaka	Winter: 6mm/d Summer: 18mm/d	6mm/day	67Ha	43.5Ha	2,600

Notes:

1. The 4.8ha allowed for irrigation in Area A relates to that portion comprising Shotover soils.
2. The dwelling capacity is based on an allowance of 1,000 L/day per dwelling and the total flow able to be irrigated at the potential design irrigation rate (DIR).
3. For Pigburn soils a more conservative DIR has been adopted (8mm/day) than that currently used (12mm/day).

The installed irrigation fields for Jacks Point Area 1 have been positioned to avoid several areas of poor quality soils related to subdivision construction operations. In addition, some 3.3ha of drip lines have been installed in advance of the intended Jacks Point village construction (which has yet to proceed) [Ref. 10]. Hence the irrigation field areas for Area 1 take up around 65% of the net area.

6.0 SELECTION OF IRRIGATION FIELD AREAS for HENLEY DOWNS

The overall irrigation field area requirement has to service some 1,750 dwellings. This could be achieved under the following options:

Option 1: The existing farmland grazing area to the west of Henley Downs (Area G) has potential for handling treated effluent from up to 2,600 dwellings. Dripline irrigation of pasture could enable continuation of sheep grazing on the resulting grass growth. Alternatively, if effluent discharge conditions require specific nitrogen reduction levels a cut and carry pasture regime could be implemented to enable harvesting of nutrient rich grass for export out of the catchment.

Area G has significant advantages in that;

- there is ample land area available for irrigating treated effluent from the proposed 1,750 dwellings equivalent;
- irrigation field areas can be developed to service individual stages of the Henley Downs development on an as-required basis;
- irrigation field operations are remote from residential areas.

Option 2: If detailed soil investigations determine the suitability for Shotover soils to accept treated effluent by drip irrigation at a DIR equal to or better than 4mm/day, then Area B (850 dwellings) plus the Shotover soil portion of Area A (190 dwellings) will accommodate the total effluent flow from the initial development proposal for 900 dwellings.

The use of Areas B and A fits well with the proposed location and layout of the Henley Downs main residential area. A modified sewerage system will provide for gravity flow to the north of the development where it would be feasible to locate the wastewater treatment plant in Area B, and then distribute treated effluent direct to adjacent irrigation fields.

However, Option 2 has insufficient land available to meet the full development level of 1,750 dwellings.

Option 3: The alternative to using Area G [Option1] or Area B (and portion of A) [Option 2] for irrigation fields would be to transfer treated effluent to the southern and eastern areas of Jacks Point where expansion of the existing irrigation areas is feasible. Areas C, D, E and F have a combined capacity of 1,335 dwellings.

However, Option 3 has insufficient land available to meet the full development level of 1,750 dwellings. Furthermore, use of Areas C to F would need to take into account any allowance for future expansion of Jacks Point.

7.0 MANAGEMENT PROCEDURES

The operation of all wastewater servicing facilities will need to be undertaken by qualified and experienced personnel, particularly if a centralised wastewater treatment plant incorporating nutrient reduction processes is to be utilised. The oversight of the Henley Downs wastewater facilities would best be amalgamated with a centralised management regime overseeing both Henley Downs and Jacks Point.

Centralised operation and management oversight would have the following elements:

- An operation and management plan dealing with all private and communal elements of wastewater servicing together with the environmental monitoring requirements related to resource consent conditions for irrigation area discharges.
- Body corporate ownership of all communal facilities including on-lot pre-treatment (Jacks Point), and communal treatment plant (Henley Downs) and land application areas for both developments.

7.0 SUMMARY

(a) The Henley Downs proposed plan change is to intensify development density in the main residential area from 10 to 12 dwellings per hectare up to 15 dwellings per hectare. The overall number of dwellings for which wastewater services are to be provided is now 1,750.

(b) Site and soil conditions have been well established for the Jacks Point development. The Shotover soils to the north of Henley Downs which have been initially identified for effluent irrigation were not characterised during the Jacks Point investigations. Information on these soils is however available from other sources.

(c) The proposed layout of the residential area involves lot sizes of 600-800m^2 for which two servicing concepts are viable:
- septic tank effluent pumping (STEP) cluster service transferring primary treated wastewater from groups of dwellings via small bore pressure sewer to a central treatment plant; or
- modified conventional sewers transferring full strength wastewater to a central treatment plant.

(d) A centralised wastewater treatment plant would produce high quality treated effluent suitable for drip irrigation. Two options are available as follows:
- AdvanTex AX-MAX recirculating textile packed bed reactor (a scaled up version of the treatment system in use for Jacks Point);
- SBR (sequencing batch reactor) system.

If need be either unit can be configured to meet discharge consent conditions for nutrient and bacterial reduction to meet discharge consent conditions.

(e) Existing developed farmland (grazing) to the west of Henley Downs has potential for irrigation of treated effluent from up to 2,600 dwellings onto Wanaka soils.

(f) If detailed site and soil investigations show the Shotover soils immediately to the north of the Henley Downs main residential area are favourable for effluent irrigation, then land could be available to take the flow from the initial development proposal for 900 dwellings of Henley Downs.

(g) Areas of suitable Pigburn and Wanaka soils adjacent to the irrigation fields for Jacks Point could be utilised for up to 1,335 dwellings.

(h) The overall best option for irrigating treated effluent from the Henley Downs development is to use the Wanaka soils in Area G to the west of Henley Downs.

(i) Centrally administered operation and management procedures should be put in place to jointly operate, maintain and monitor both the Jacks Point and Henley Downs wastewater services.

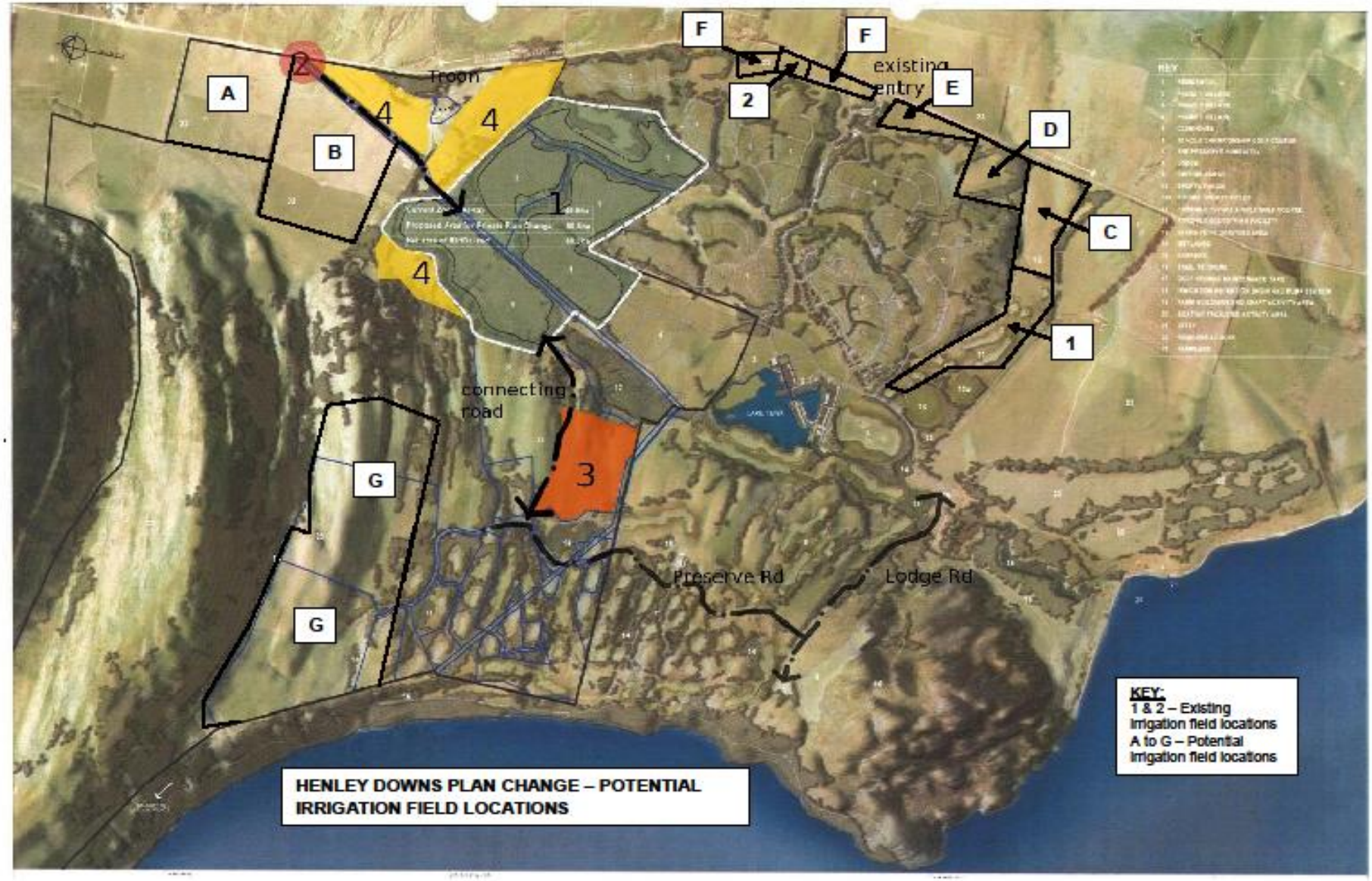
****

ATTACHMENT: Henley Downs Plan Change – Potential Irrigation Field Locations

REFERENCES:

1. John Edmonds Associates (September 2012) Henley Downs Plan Change, PowerPoint Presentation
2. Arith/Henley Downs (October 2009) Proposed Plan Change – Site Plan (mark-up based on Darby Partners layout)
3. Coneburn Area Resource Study (October 2002)
4. Hewitt, A. E.(September 2001) Soils of Jacks Point Development, Queenstown, Landcare Research, Lincoln
5. Glasson Potts Fowler Ltd (January 2003) Soil Survey and Site Suitability for Discharge of Domestic Wastewater at Jacks Point, for Darby Partners Ltd
6. Glasson Potts Fowler Ltd (June 2004) Jacks Point Sewerage System Preliminary Design and Option Assessment Report, GPF Christchurch
7. Innoflow Technologies Ltd (January 2008) Community Wastewater Management Case Study – Jacks Point, Queenstown, NZ, www.innoflow.co.nz
8. Landcare Research (1991) National Soils Database, NSD Web Viewer
9. Thomson, Royden (18 October 2011) Henley Downs Farms Ltd: Geotechnical Appraisal of the ORC Submission Regarding Alluvial Fan Hazards at the Proposed Delta Depot, Woolshed Road, Report to Clark Fortune McDonald & Associates, Queenstown
10. Hawthorn, Brent (23 and 31 October 2012) Personal Communication, Innoflow Technologies Ltd

ATTACHMENT


A
B
2
4
4
Troon
1
4
F
F
2
existing entry
E
D
C
1
connecting road
3
G
G
Preserve Rd
Lodge Rd
KEY:
1 & 2 – Existing irrigation field locations
A to G – Potential irrigation field locations
HENLEY DOWNS PLAN CHANGE – POTENTIAL IRRIGATION FIELD LOCATIONS