Kiwitea Stream
Gravel Resource Study

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Author
Stuart Standen
River Management Analyst

Acknowledgements to
Jon Bell
Senior Design Engineer

Peter Blackwood
Manager Design and Investigations

Quentin Gilkison
Surveyor

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CONTACT	**24 hr Freephone 0508 800 800**	**help@horizons.govt.nz**		**www.horizons.govt.nz**
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POSTAL ADDRESS	Horizons Regional Council, Private Bag 11025, Manawatu Mail Centre, Palmerston North 4442				F 06 9522 929

FOREWORD

This study examines the gravel resources in the Kiwitea Stream based on an analysis of stream cross section information. The study area covers the length of the Kiwitea Stream from its confluence with the Oroua River to the Cheltenham Hunterville Road Bridge, Cheltenham.

Analysis of four cross section surveys carried out during 1985, 2004, 2010 and 2016 has identified that the following is occurring in the Kiwitea Stream study area:

- The stream bed is degrading in the upper half of the study area and aggrading in the lower half;
- The volume of gravel under the stream bed is degrading in the upper half of the study area and aggrading in the lower half;
- The volume of gravel under the active channel is relatively stable in the upper ¾ length of the study area with a pronounced aggradation occurring in the lower quarter;
- The cumulative change shows a loss of gravel under the stream bed occurred between 2010 and 2016 while aggradation occurred between 1985 and 2004; and
- The cumulative change of gravel shows the volume of gravel under the active channel has built in the lower half of the study area.

Based on the results of this study it is recommended that:

1. Gravel extraction from the Lower Kiwitea Stream Scheme be only allowed downstream of cross section 8000;
2. That the maximum annual amount of gravel to be extracted and removed from the Kiwitea Stream shall not exceed 5,000 cubic metres per annum as per resource consent 103434/1; and
3. The Kiwitea Stream study area is resurveyed in the year 2021.

CONTENTS

Kiwitea Stream Gravel Study

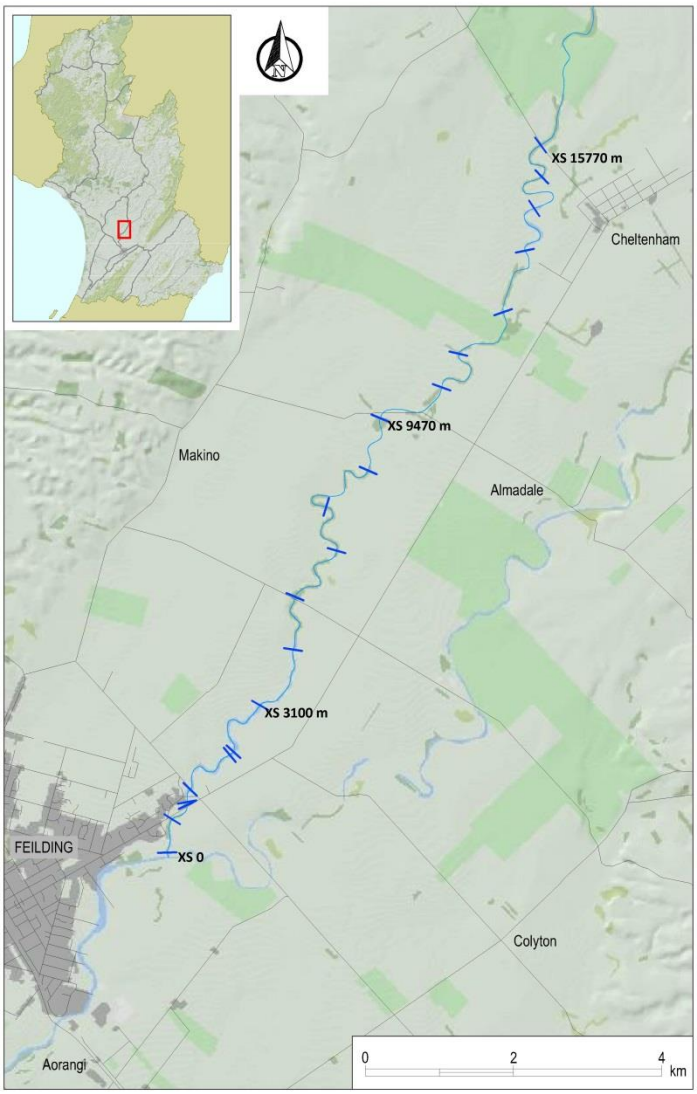
1. Introduction

This study examines the gravel resources in the Kiwitea Stream based on an analysis of stream cross section information. It covers the 15.77 km reach of the stream from the stream's confluence with the Oroua River to the Cheltenham Hunterville Road Bridge, Cheltenham. The study area is located within the Lower Kiwitea Stream Scheme with the addition of two survey cross sections located on the Kiwitea Stream downstream of the Reid Line West Road. These two additional cross sections are located in the Lower Manawatu Scheme. The location of the study reach is shown in Figure 1 below.

This study has focused on information from surveys of the stream conducted in 1985, 2004, 2010 and 2016, as they provide the most complete record of the stream.

This study examines the gravel resources of the Kiwitea Stream located within the study area and the change in the stream bed level over time.

Figure 1 Location of Kiwitea Stream Study Area and Cross Section Locations



KIWITEA STREAM

2. Cross Section Survey Data

This study has focused on stream cross section surveys carried out during 1985, 2004, 2010 and 2016. Figure 2 shows when each cross section location, measured in metres from the Oroua River confluence, has been completed. The cross sectional surveys have not been carried out consistently at each cross section location. For example, cross section location 0 was surveyed during 1985, 2004 and 2016 and not during 2010. Cross section location 460 was surveyed during 2010 and 2016 only. This must be kept in mind when comparing one set of survey data to another.

Figure 2 Kiwitea Stream survey schedule

Survey Schedule

Distance from the Oroua River Confluence (metres)	1985	2004	2010	2016
0	✓	✓		✓
460			✓	✓
800	✓	✓		✓
820	✓	✓		✓
950			✓	✓
2000	✓	✓		✓
2180			✓	✓
3000	✓	✓		
3100			✓	✓
4180			✓	✓
5000	✓	✓		
5070			✓	✓
6140			✓	✓
7220			✓	✓
8000	✓	✓		
8300			✓	✓
9470			✓	✓
10000	✓	✓		
10520			✓	✓
11000	✓	✓		
11370			✓	✓
12000	✓	✓		
12400			✓	✓
13000	✓	✓		
13370			✓	✓
14000	✓	✓		
14300			✓	✓
15040			✓	✓
15770	✓	✓		✓

3 Analysis of Cross Section Survey Data

To determine the change in gravel resources of the Kiwitea Stream the gravel volume under the stream bed and under the active channel has been calculated. For this study the stream bed has been defined as the channel bottom of the stream that contains the normal water flow. The active channel is defined as the area that includes the stream bed and the gravel beaches. Also assessed in this study is the change in the mean stream bed level and stream bed invert at each cross section.

The purpose of assessing the change in volume of gravel and bed level at each cross section is to highlight any trends of stream aggradation or degradation that may be occurring to the gravel resource of the Kiwitea Stream. The analysis of the active channel will highlight any changes to the gravel resources found on the stream's banks and beaches.

3.1 Analysis of the Gravel Resources Beneath the Bed of the Kiwitea Stream

To calculate the volume of gravel under the bed of the stream each cross section was analysed individually. HILLTOP software was used to calculate the area under each cross section between the extents of the stream bed to an assumed datum level. These cross sectional areas were then integrated over half the distance to the next upstream and downstream cross section to obtain a volume. While this volume would include all material, and not just gravel, between the stream bed and the assumed datum level, it is reasonable to assume that any change between surveys will be due to the movement of gravel on the bed of the stream and any gravel extraction.

3.2 Analysis of the Gravel Resource Beneath the Active Channel of the Kiwitea Stream

To calculate the volume of the gravel under the active channel of the stream each cross section was analysed individually. HILLTOP software was used to calculate the area beneath each cross section between the extents of the active stream channel. These cross sectional areas were then integrated over half the distance to the next upstream and downstream cross section to obtain a volume. This volume would include all material, and not just gravel, between the stream bed and the assumed datum level. It is reasonable to assume that any change between surveys will be due to the movement of gravel on the active channel of the stream.

3.3 Analysis of the Kiwitea Stream Bed and Bed Level

The surveyed profiles of each cross section have been plotted using the over plot function on Manager. HILLTOP software has been used to calculate the mean stream bed level and the bed invert level for each cross section survey date.

4 Results

4.1 Analysis of Gravel Beneath the Kiwitea Stream Bed

Figure 3 below shows the change in the gravel volume at each cross section when compared to the gravel volume obtained by the previous survey. Figure 4 shows the same data as Figure 3 minus the outliers which are associated with lateral erosion on the stream bank at cross section points 2000, 3000 and 7220. These two figures show that there is a degradation trend occurring in the top half of the study area while an aggradation trend is occurring in the bottom half the study area.

Figure 3 Change in gravel volume under the stream bed

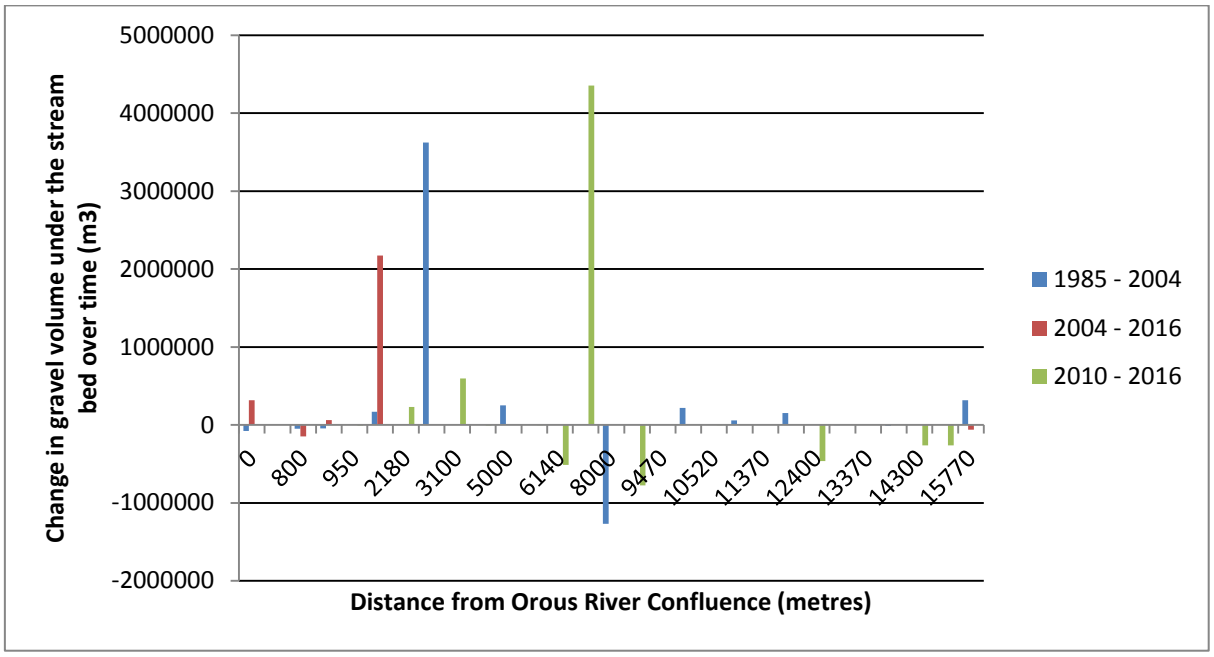
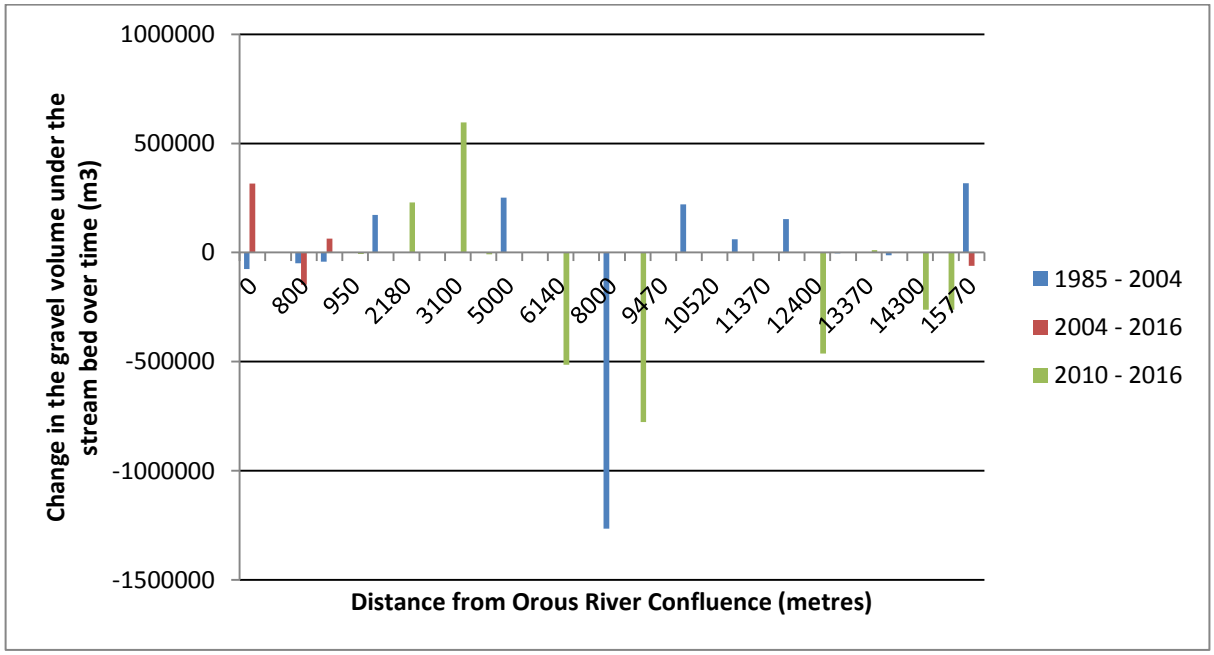


Figure 4 Change in gravel volume under the stream bed (minus outliers)



4.2 Analysis of Gravel Beneath the Active Channel of the Kiwitea Stream

Figure 5 below, shows the change in the volume of gravel under the active channel at each cross section over time. Again, as mentioned above, the large increases are associated with a change in the stream channel form. Figure 6 shows the same minus the outliers.

Figure 5 Change in the gravel volume under the active channel

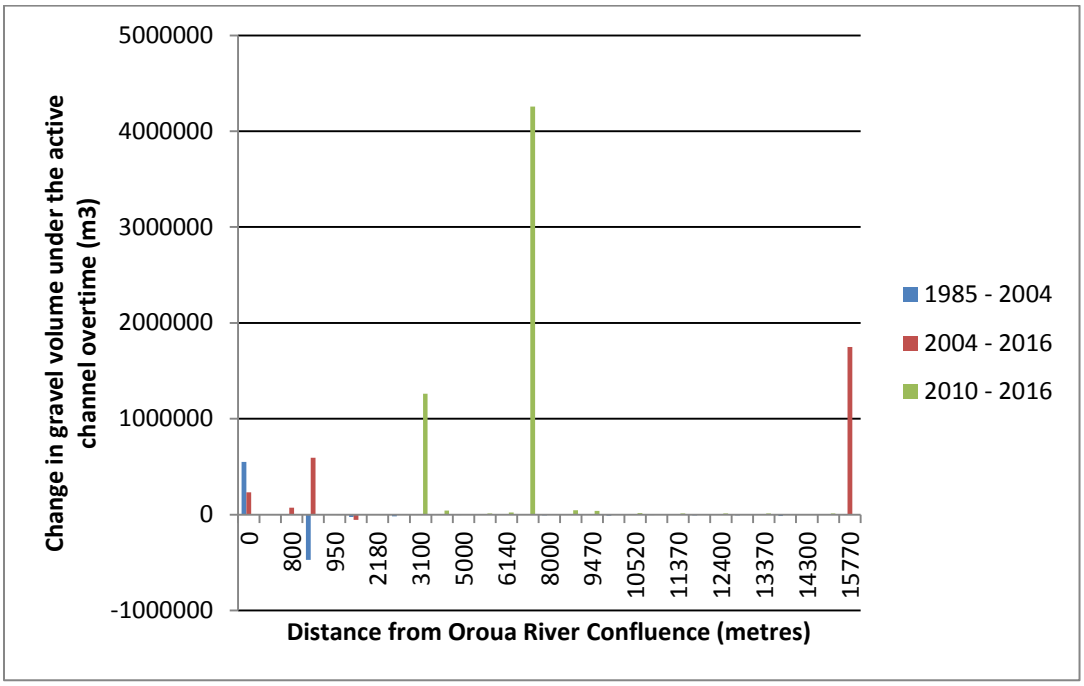


Figure 6 Change in the gravel volume under the active channel (minus outliers)

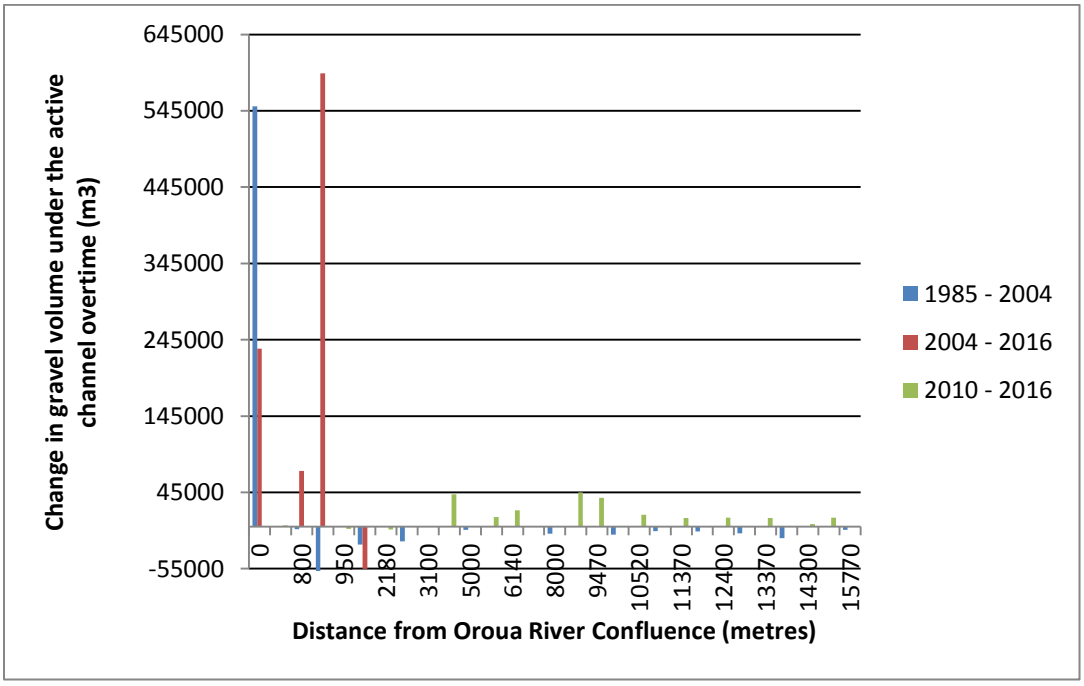


Figure 6 shows that the volume of gravel under the active channel has remained relatively constant over time from cross section 2180 to cross section 15770. Conversely, the gravel volume has increased from the Oroua River confluence to cross section 820.

4.3 Analysis of Stream Bed Level

Figure 7 below shows the change in the mean bed level at each cross section location over time. The purpose of this analysis is to determine if the bed level is aggrading or degrading over time. This shows that degradation is the dominant process in the upper half of the study area while a combination of degradation and aggradation is occurring in the lower half of the study area.

Figure 7 Change in mean bed level

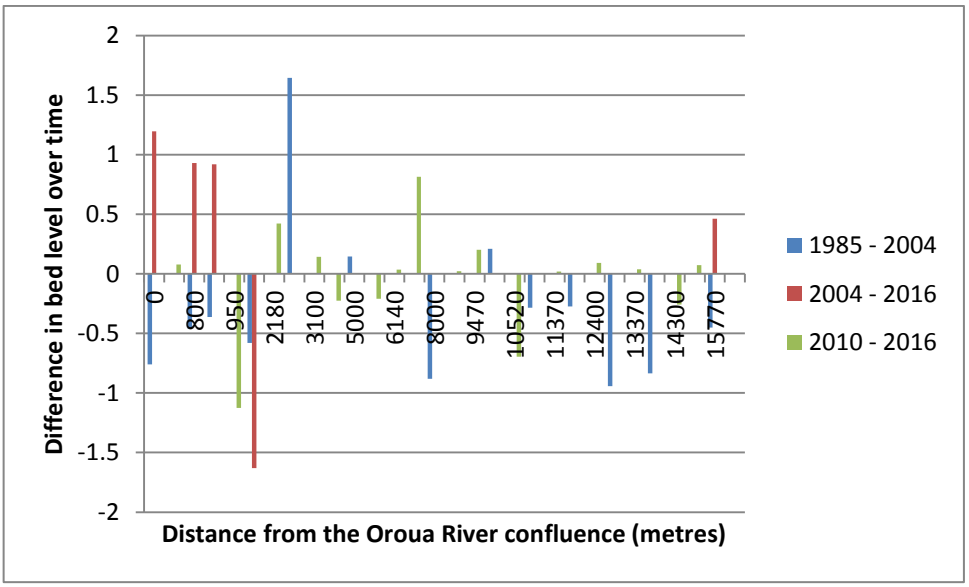
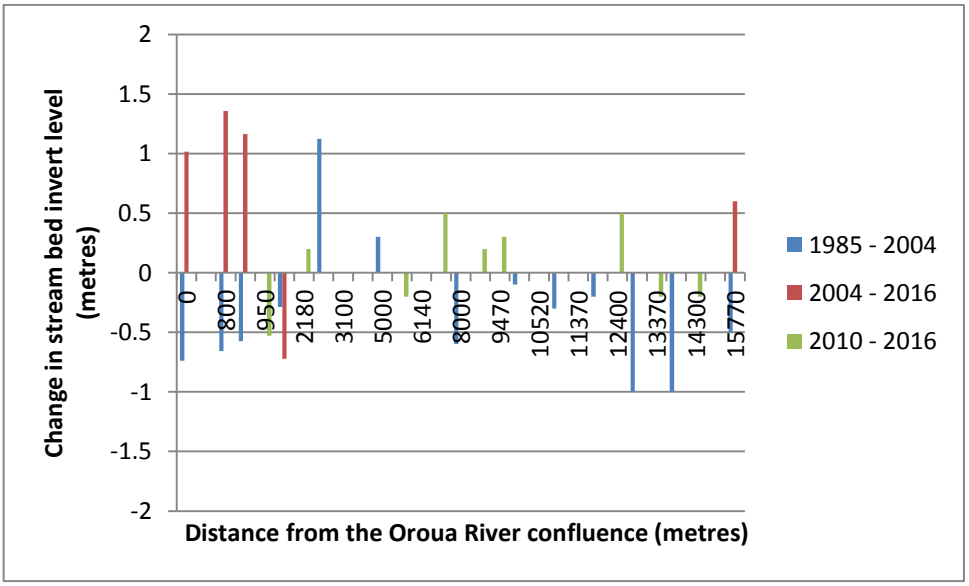


Figure 8 below shows the change in the bed invert at each cross section location over time. The purpose of this analysis is to determine if the bed invert is aggrading or degrading over time and to compare the change in invert pattern to the change in the mean bed level pattern.

Figure 8 shows that the degradation process is the dominant process upstream of cross section 8000 while a mix of degradation and aggradation is occurring downstream of this cross section. This pattern matches the pattern of the mean bed level. With both Figures 7 and 8 identifying the same pattern the aggradation/degradation conclusion for the Scheme.

Figure 8 Change in bed invert level



4.4 Cumulative Change of Gravel Volume

Figure 9 below shows the cumulative change in the gravel volume under the stream bed over time. The cumulative change has been calculated commencing from the uppermost cross section (i.e. point 15770) and working to the confluence of the Oroua River. This shows that for the period 1985 – 2004 there was an accumulation of gravel under the stream bed for the majority of the Scheme length with minor gravel loss near the Oroua River confluence. For the period of 2004 – 2016 there were some minor losses and gains of gravel over the Scheme length. For the period 2010 – 2016 there were some substantial losses of gravel in the upper half of the Scheme reach with gravel gains occurring in the lower third reach of the Scheme.

Figure 9 Cumulative change in the gravel volume under the stream bed (minus outliers)

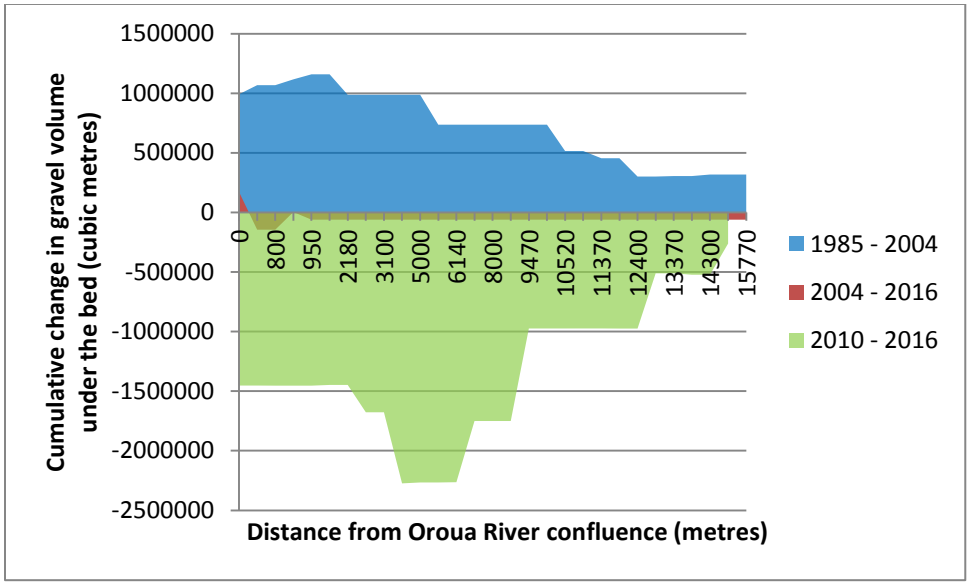
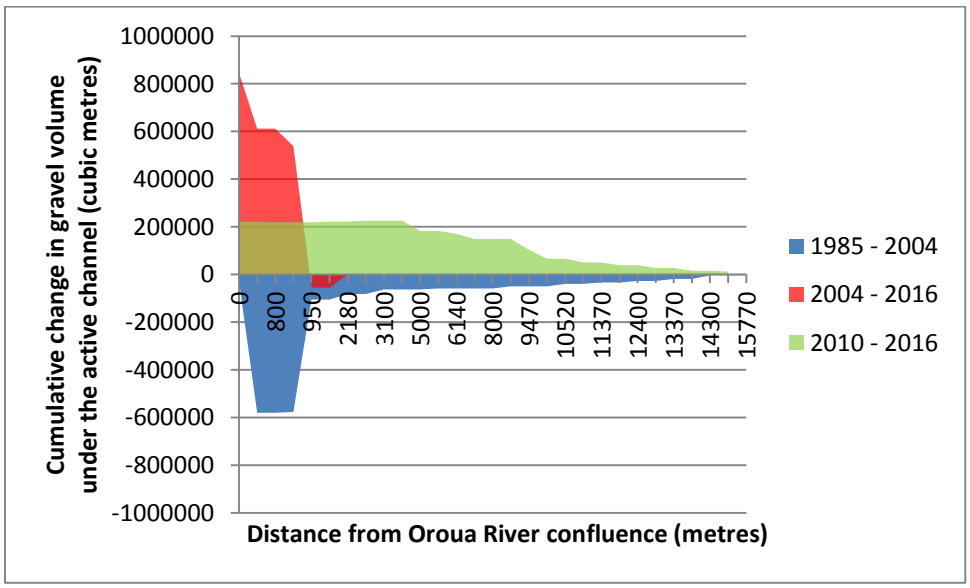


Figure 10 below shows the cumulative change in the gravel volume under the active channel over time. The cumulative volume has been calculated in the same manner as discussed above. This shows that gravel has not accumulated in the upper third section of the stream over the three different survey comparisons, while the majority of gravel accumulation has occurred in the lower portion of the scheme reach. This indicates that the movement of gravel is occurring under the stream bed while the gravel resources of the beaches remain stable.

Figure 10 Cumulative change in the gravel volume under the active channel (minus outliers)



5 Gravel Extraction

18,580 cubic metres of gravel has been extracted in the Lower Kiwitea Stream Scheme since 2006. The gravel has predominately been extracted from the lower to middle reaches of the Scheme with sporadic abstractions occurring in the upper reach. This extraction is authorised by resource consent 103434/1 which expires on 15 May 2026.

6 Conclusion

The main findings of this study is that the survey data supports the notion that there is a general trend of degradation occurring in the upper half of the study area and a mixed trend of aggradation/degradation occurring in the lower half. This means that the gravel resource and stream bed level is decreasing in the upper half and increasing in the lower half of the study area.

When considering these results it must be kept in mind that the quantity of gravel surveyed in 2016 is being assessed the quantity of gravel surveyed in previous years. Since the previous surveys there have been several large floods which caused significant damage to Scheme assets and the stream alignment. In addition the survey schedule contains a mixture of cross sectional survey locations and survey times which limits the use of the data to precisely pinpoint gravel trends within the Scheme.

Based on the results of this study it is recommended that:

4. Gravel extraction from the Lower Kiwitea Stream Scheme be only allowed downstream of cross section 8000;
5. That the maximum annual amount of gravel to be extracted and removed from the Kiwitea Stream shall not exceed 5,000 cubic metres per annum as per resource consent 103434/1; and
6. The Kiwitea Stream study area is resurveyed in the year 2021.

Appendix A: Mean Kiwitea Stream Bed Heights (metres)

Chainage	1985	2004	2010	2016
0	79.275	78.516		79.712
460			83.443	83.522
800	85.16	84.7		85.63
820	85.137	84.774		85.692
950			87.489	86.364
2000	95.315	94.736		93.105
2180			94.025	94.446
3000	99.535	101.179		
3100			100.962	101.105
4180			107.617	107.391
5000	111.587	111.732		
5070			113.721	113.511
6140			119.044	119.079
7220			125.104	125.919
8000	129.738	128.856		
8300			132.057	132.078
9470			136.477	136.678
10000	140.315	140.525		
10520			143.703	143.008
11000	145.86	145.576		
11370			148.53	148.548
12000	152.509	152.234		
12400			155.095	155.187
13000	158.107	157.164		
13370			160.597	160.634
14000	165.398	164.563		
14300			166.374	166.117
15040			172.142	172.214
15770	175.776	175.324		175.787

Appendix B: Change in Gravel Volume Under the Kiwitea Stream Bed

Distance (m)	1985 - 2004	2004 - 2016	2010 - 2016
0	-76130	316043	
460			840
800	-48798	-147978	
820	-42441	64014	
950			-5895
2000	171708	2173594.5	
2180			229344.8
3000	3623115		
3100			596549
4180			-7695
5000	250891		
5070			-2223
6140			-513420
7220			4355469
8000	-1265436		
8300			-776307
9470			85
10000	220972.5		
10520			-250
11000	60605		
11370			750
12000	153676		
12400			-463200
13000	-4025.5		
13370			11500
14000	-12787.5		
14300			-261404
15040			-261404
15770	317915	-60736	

Appendix C: Change in Gravel Volume Under the Kiwitea Active Channel

Chainage	1985 - 2004	2004 - 2016	2010 - 2016
0	550873	233151	
460			1720
800	-3276	73206	
820	-471762.5	593915.5	
950			-2882
2000	-23185.5	-55350	
2180			-3801.2
3000	-19140		
3100			1262069
4180			42655
5000	-4049.5		
5070			12540
6140			21500
7220			4256145
8000	-8964		
8300			44908.5
9470			37910
10000	-10447.5		
10520			15750
11000	-5780		
11370			11450
12000	-6128.5		
12400			11700
13000	-8750		
13370			11500
14000	-14900		
14300			3450
15040			12100
15770	-3950	1747550	

Appendix D: Stream Bed Invert Height (metres)

Distance (m)	1985	2004	2010	2016
0	78.84	78.102		79.117
460			82.717	82.713
800	84.586	83.929		85.286
820	84.959	84.385		85.547
950			86.645	86.115
2000	93.233	92.946		92.223
2180			93.854	94.054
3000	99.485	100.609		
3100			100.8	100.8
4180			107.3	107.3
5000	111.1	111.4		
5070			113.5	113.3
6140			118.9	118.9
7220			124.4	124.9
8000	128.9	128.3		
8300			131.4	131.6
9470			136.3	136.6
10000	140.1	140		
10520			142.9	142.9
11000	145.7	145.4		
11370			148.4	148.4
12000	151.2	151		
12400			153.9	154.4
13000	157.8	156.8		
13370			160.2	160
14000	165.1	164.1		
14300			166.2	166
15040			172	172
15770	175.4	174.9		175.5