Tonkin & Taylor

Appendix E: Interpolation

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

E.1. Introduction and Interpolation Summary

This appendix presents a brief summary of the interpolation process to infer calculated liquefaction parameters between CPT.

This appendix also sets out the process by which interpolation of LPI, S and LSN values are undertaken. The sites are interpolated and then minor extrapolation is carried out. The extrapolation is used around the perimeter of the site investigation regions to include areas that are within 50 m of a site investigation location.

In addition to the interpolation process described above, a pre-interpolation process is applied to the LSN parameter called the LSN slice method. CPT within 50 m of each other and within a similar geologically area can contribute towards the LSN layers of a CPT which do not have a LSN value due to missing CPT data either because the CPT were terminated before 10 m depth or because the CPT were pre-drilled. As a result, LSN values are expected to be more reliable as they use contributing LSN values from neighbouring CPT instead of making assumptions that either the layers liquefy (in the case of pre-drill) or do not liquefy (in the case of the CPT terminating before 10 m depth).

E.2. LSN slice process

The general methodology applied is as follows:

1. LSN is calculated for each CPT and is then broken down into 16 contributing slices in the upper 10 m (see Figure E1). The contribution from slices below 10 m is not considered.
2. All CPT data is taken into account and the LSN values are calculated for each of the slices.
3. Slices which are in the pre-drill part of the CPT <u>and</u> extend deeper than the groundwater table <u>or</u> which stop short of 10 m are replaced with “NULL” values.
4. All slices above the median groundwater table are assigned an LSN value of 0 (regardless of whether they are in the pre-drill part of the CPT) as they are not assessed as potentially liquefiable.
5. CPT containing any NULL values are identified. The slice layers from surrounding CPT in a geologically similar area (based on the areas shown in Figure E2) and within 50 m are used to replace the NULL value with an LSN value.
6. A proportional distance weighting is used if more than 1 CPT in a geologically similar area are within 50 m and able to contribute to the slice LSN value.
7. CPT which are shorter than a depth of 5 m are not extended using the LSN Slice methodology (i.e. all CPT are used to contribute towards slice LSN values but only CPT greater than 5 m deep are extended to 10 m if neighbouring CPT data is available).

Figure E3 shows a working example of the CPT slice interpolation method to calculate an adjusted LSN value. This process has only been applied to the LSN parameter, but not the LPI and S parameters. These are planned for consideration in future updates to this report.

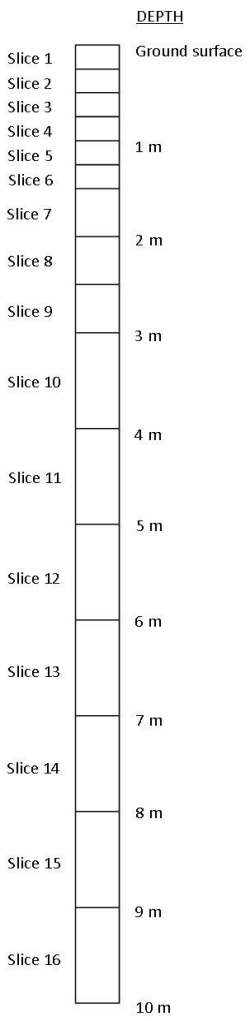

Figure E1 – Top 10 m of the soil profile broken down into slices

Waimakariri River - Avon River

Avon River - Heathcote River

Heathcote River - Port Hills

Port Hills

Kaipoi North

Kaipoi River - Waimakariri River

Waimakariri River - Avon River

Inset: Kaiapoi & Northern Suburbs

Legend

Zones

- Kaipoi North
- Kaipoi River to Waimakariri River
- Waimakariri River to Avon River
- Avon River to Heathcote River
- Heathcote River to Port Hills
- Port Hills

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A3 SCALE 1:60,000

0 1 2 3 4 (km)

N

Inset Map

Location Plan

EQC EARTHQUAKE COMMISSION Kōmihana Rūwhenua

DRAWN	JEL	Feb.13
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APPROVED		
ARCFILE 52020-0200-LSN156		
SCALE (AT A3 SIZE) 1:60,000		
Prepared by Tonkin & Taylor Ltd. Ref: 52020-0200		

EARTHQUAKE COMMISSION
CHRISTCHURCH CITY & KAIAPOI
Slice Interpolation Zones

FIGURE No. Figure E2

Rev. 0

Date: 18/02/2013 Time: 9:12:19 a.m.

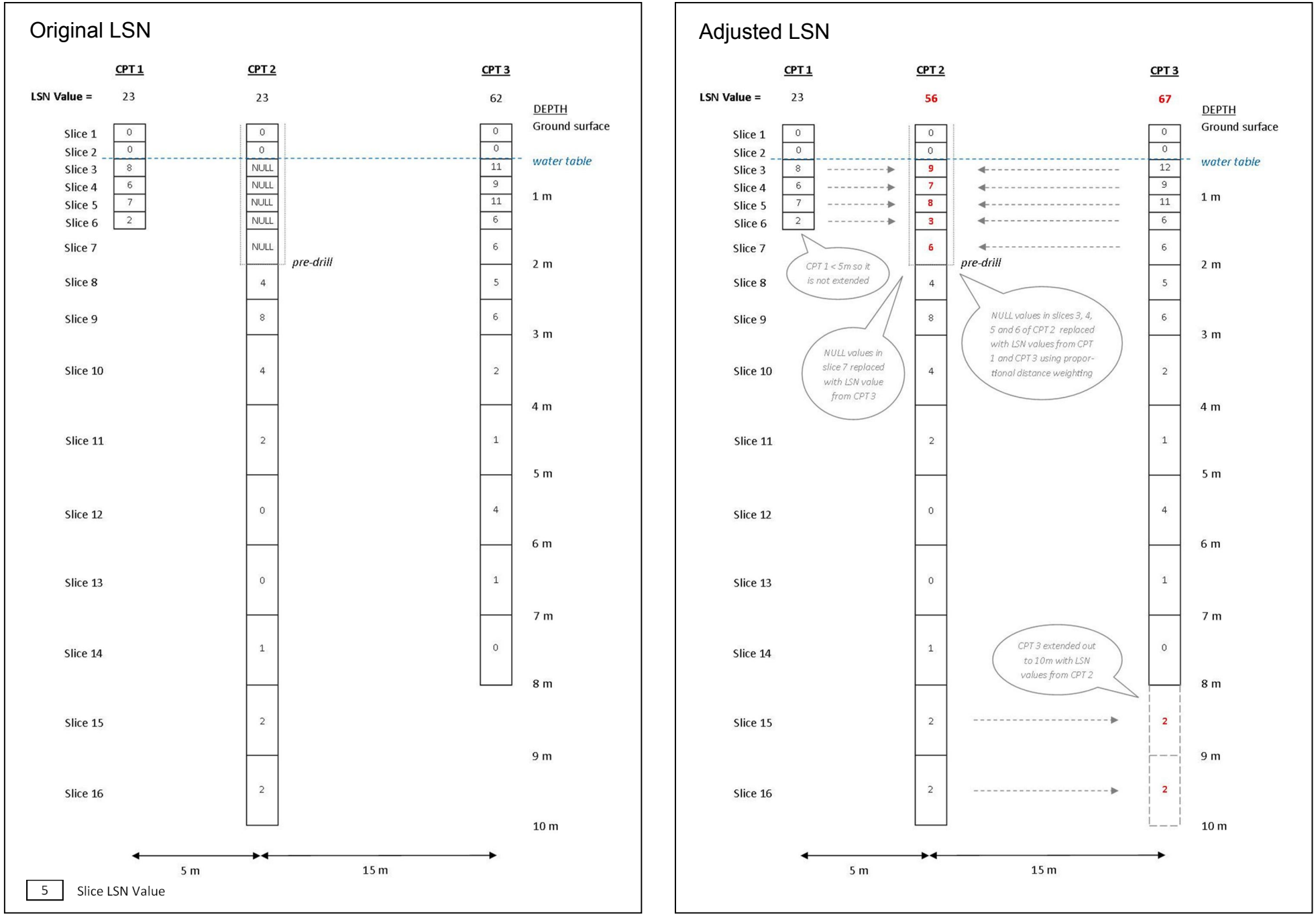


Figure E3 - Schematic example of the LSN slice interpolation method

E.3. Interpolation Process

The interpolation is based on the Natural Neighbour (NN) method with inverse distance weighting (Shepard's basic formulae). The general methodology used to apply these methods is as follows.

1. The location and value of the complete set for interpolation is plotted. Interpolation boundaries are then applied along major watercourses, geological units and other obvious locations
2. Each of the sub-areas that is produced is interpolated separately using natural neighbours and the result is clipped back to its' defined boundary.
3. The results are then mosaicked to create a single continuous grid of data results

Figure E5 identifies which CPT are excluded from the interpolation process. The red CPT on the map are less than 5 m deep or have a pre-drill depth greater than 2 m and are therefore excluded from the analyses.

Following this process, a minor extrapolation at the perimeter of the grid is carried out.

E.4. Extrapolation Process

1. All data points that are less than 50m from the boundary are selected
2. The values of each are extrapolated for each grid cell up to 50m beyond the boundary as shown in the graphical information below. No extrapolation is carried out across any defined break line
3. Where a grid cell would fall within 50 m of more than one CPT Inverse Distance Weighting (IDW) is applied to derive the value at that point. The factor of k used for IDW is 2.
4. The Interpolated grid is then overlayed on the extrapolated grid to produce the final grid.

E.5. Schematic Example of the Interpolation and Extrapolation Process

A series of figures showing the extrapolation is set out below.

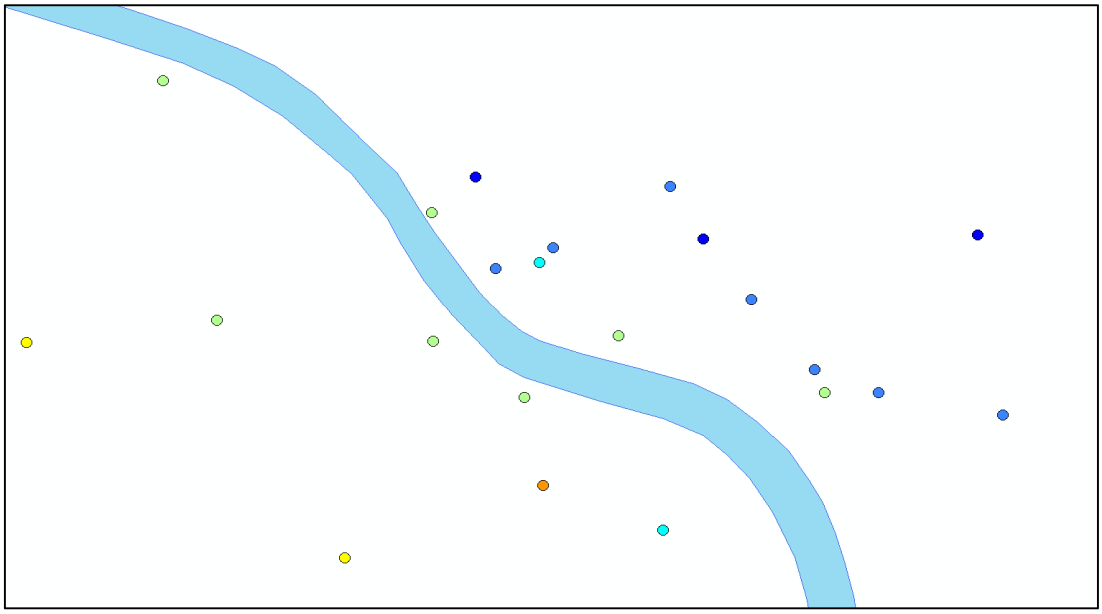


Figure E4.A - Step 0: Locations of CPT and river

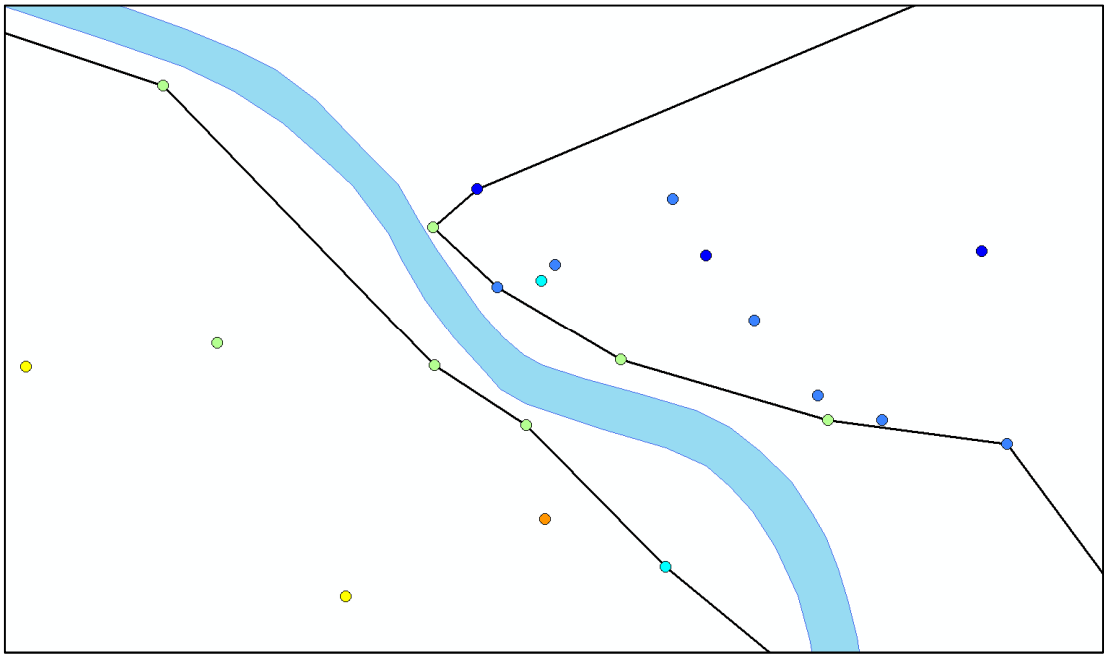


Figure E4.B - Step 1: Find points on boundary edge

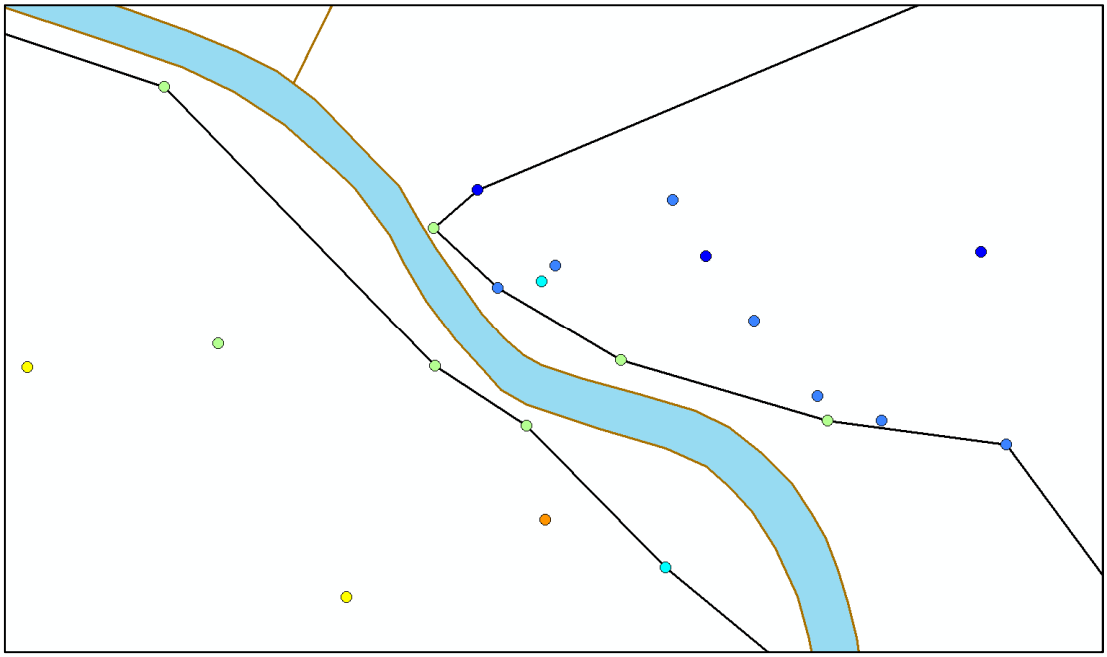


Figure E4.C - Step 2: Define rivers and other boundaries

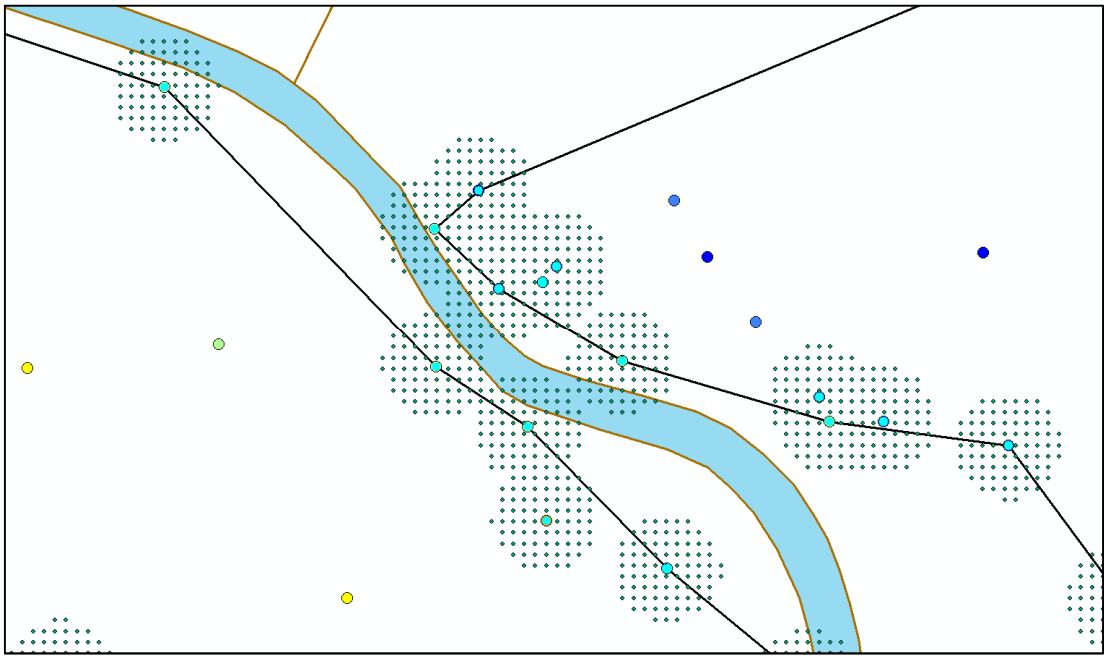


Figure E4.D - Step 3: Grid Points within 50 m

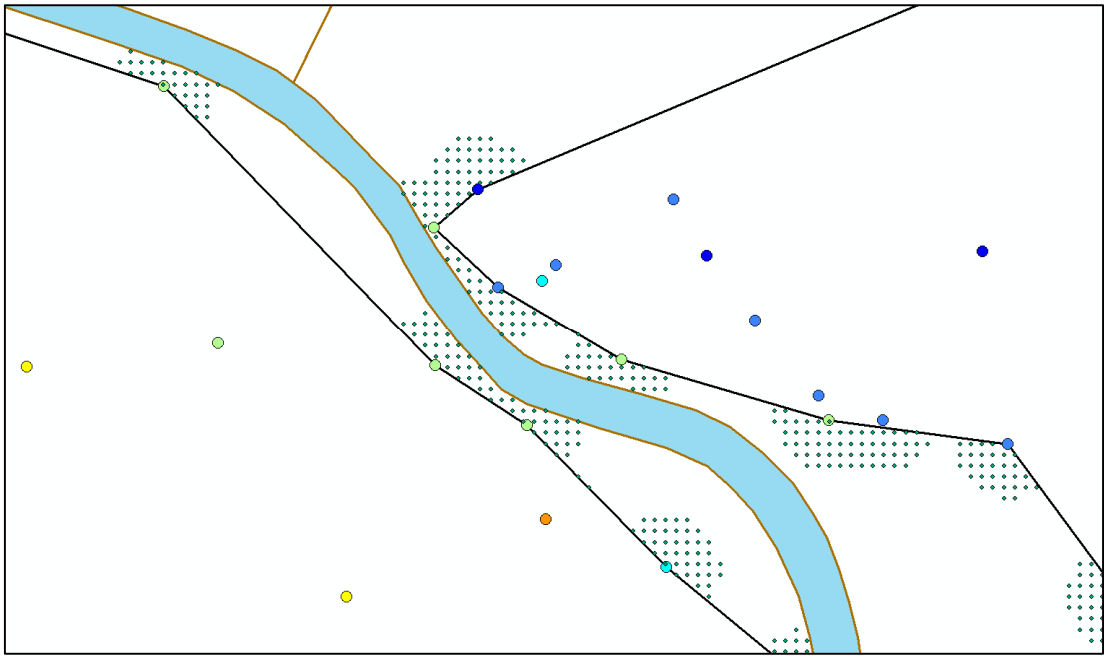


Figure E4.E - Step 4: Exclude points within boundary

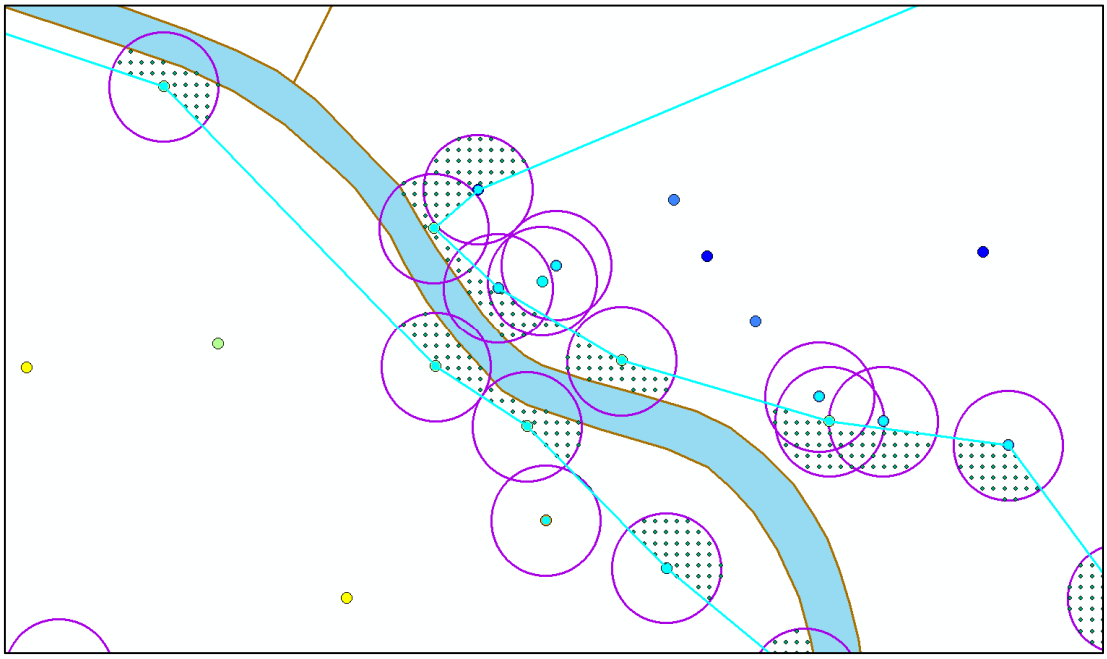
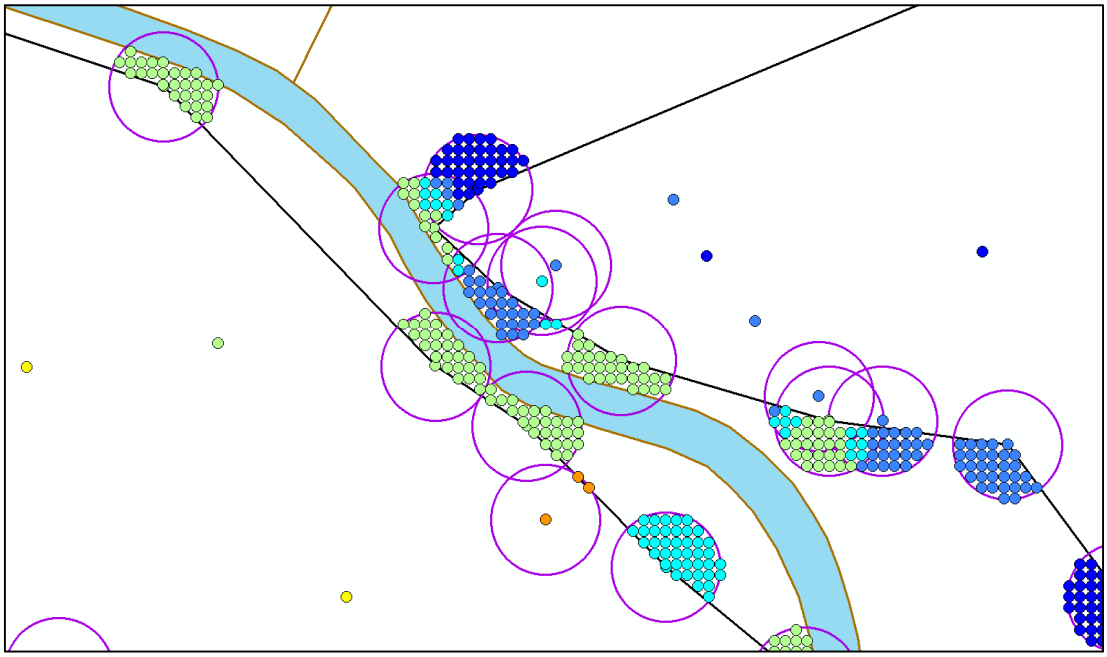


Figure E4.F - Step 5: Assign points by radii

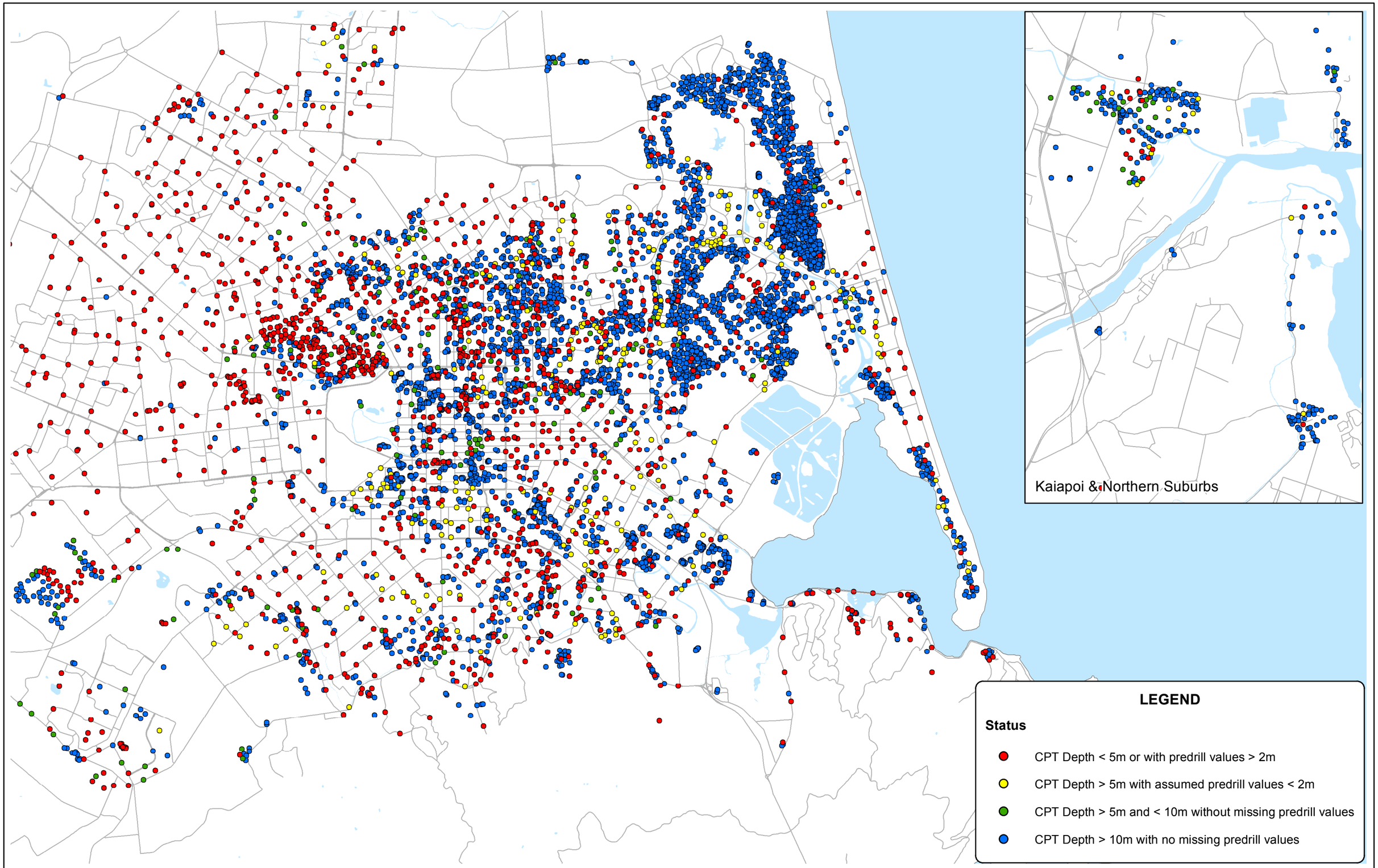


NOTE The highlighted grids are based on Interpolated IDW values. The other grid values outside the boundary are assigned.

Figure E4.G - Step 6: Rasterize values and overlay with NN interpolated values

The extrapolation process is applied to the LPI, S and LSN parameters.

The CPT distribution and the interpolation boundary used for all analyses in this report are presented in Figure E6.



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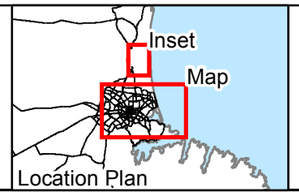
A3 SCALE 1:60,000

0 1 2 3 4 (km)



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ARCFILE 52020-0200-LSN155
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CPT Locations

FIGURE No. Figure E5

Rev. 0

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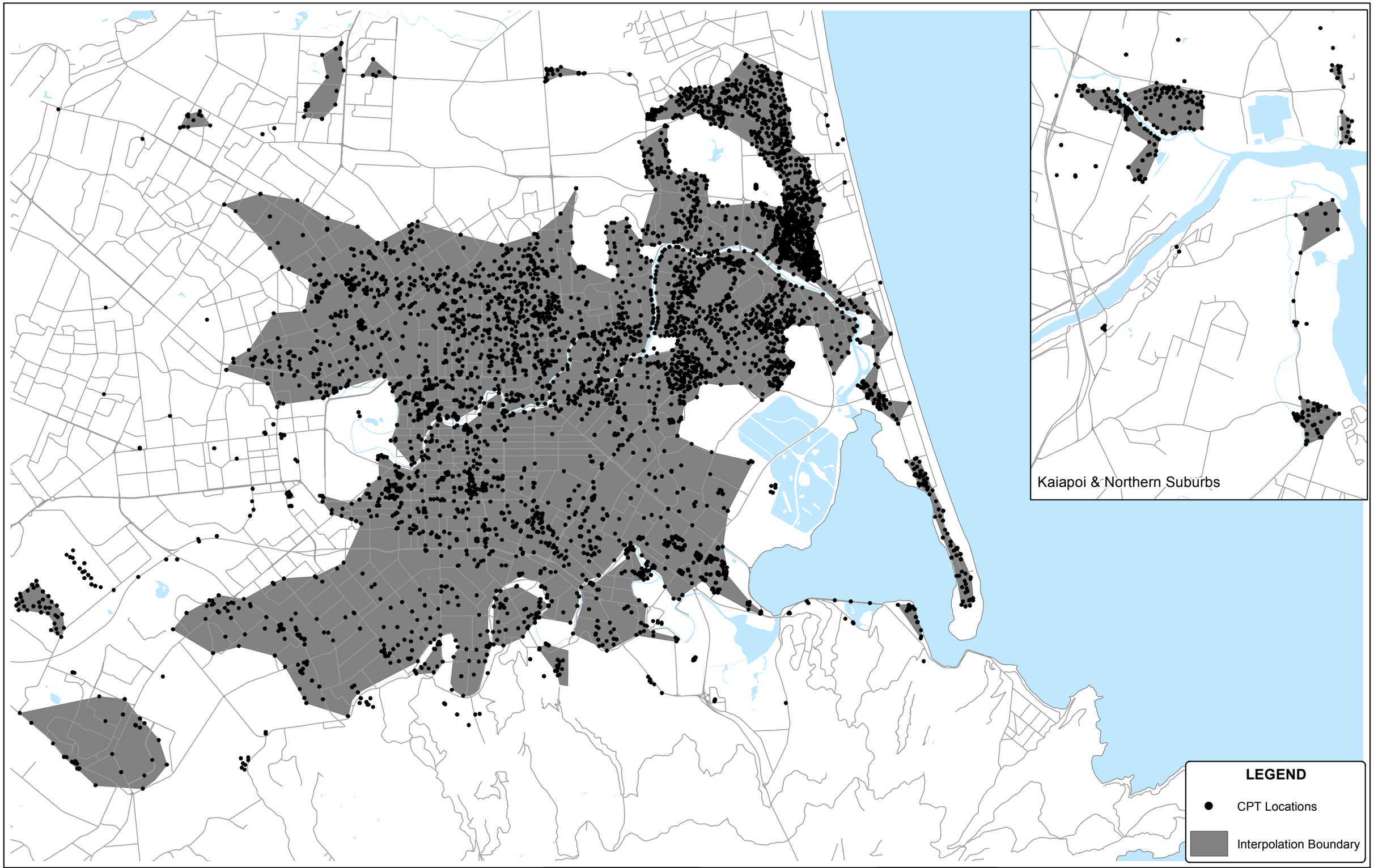

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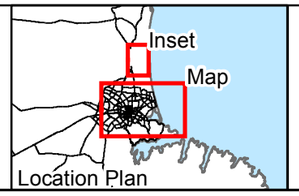
A3 SCALE 1:60,000

0 1 2 3 4 (km)



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SCALE (AT A3 SIZE) 1:60,000		
PROJECT No. 52020-0200		

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Spatial Distribution of CPT's and Interpolation Extents used in the Liquefaction Vulnerability Study

FIGURE No. Figure E6

Rev. 0

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