MEMORANDUM

To	Michael MacDonagh | Greater Shepparton City Council
From	Lachlan Inglis | Water Technology
Date	17 May 2022
Subject	Shepparton South East Precinct Structure Plan
Our ref	22010358_M01V02.docx

Water Technology was engaged by Greater Shepparton City Council (GSCC) to undertake an assessment of the Shepparton South East Precinct Structure Plan (SSEPSP), with the latest available flood modelling information. This memo introduces the study, the existing flood modelling results and summary of development footprints assessed for the proposed future conditions for the precinct.

1 BACKGROUND

The development of two detailed flood models of the SSEPSP was required to provide information on developable land and the broader context of flooding and drainage along the growth corridor. To the north of channel Road, the BMT Shepparton East flood study provides information on the existing flood behaviour within the area which is impacted by stormwater runoff from the local catchment. To the south of Channel Road, parts of the SSEPSP are impacted by flooding from the Broken River. This report focuses on the southern portion of the SSEPSP.

The SSEPSP is part of a broader growth corridor located in Shepparton East and comprises an area of approximately 180ha. It is bounded by an existing drainage outfall to the west (Drain 2), the Broken River to the south, Doyles Road to the east and Channel Road to the north (Figure 1).

Since the completion of the Channel Road Model of Flood Behaviour project (Water Technology, 2018), the Shepparton Mooroopna Flood Mapping and Flood Intelligence project, with the inclusion of climate change (Water Technology, 2021) has been completed and adopted by Council. This superseded the 2018 study and is known as the Shepparton Mooroopna 1% AEP Flood Mapping Project (2021). The current study utilised updated LiDAR datasets (collected in early 2020) and a more defined model grid resolution to produce flood mapping and flood intelligence information. Therefore, an update to the 2018 Channel Road Model of Flood Behaviour study was required to bring the information for the investigation area in line with the most recent flood modelling information.

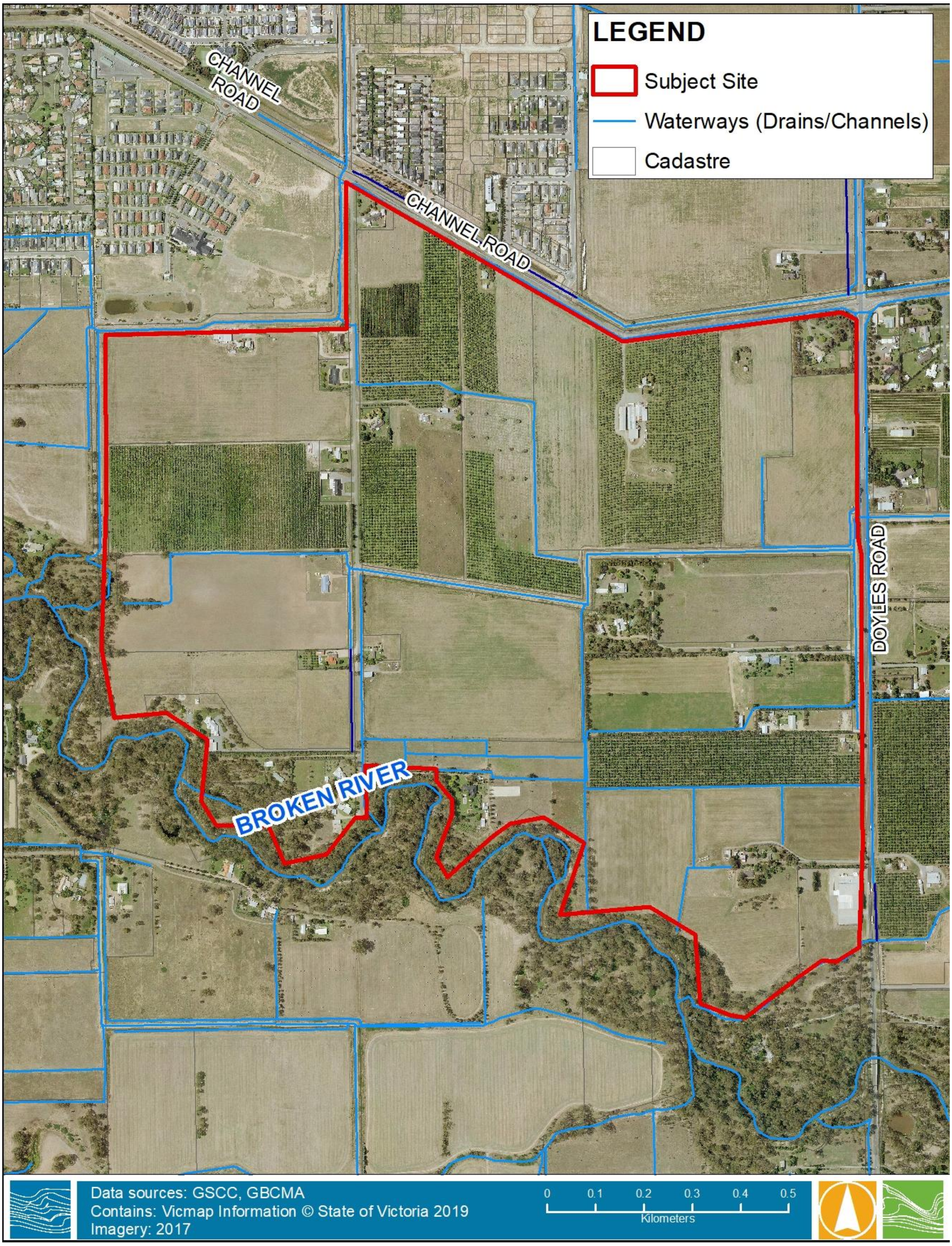

Figure 1 Shepparton South East PSP (Southern Section)

1.1 Shepparton South East Precinct Structure Plan

As part of the study undertaken in 2018, a series of model scenarios were carried out to assess the floodplain management suitability of development. The key criteria assessed included:

- No negative impact to flood levels outside study site.
- Any loss of floodplain storage be compensated with the addition of 130% of the floodplain storage volume removed.

The 2018 report covered riverine flooding requirements and mapping of the site flood behaviour. It also included a recommended development layout which may allow for a future planning scheme amendment, potentially enabling landholders to excise their land for development.

Based on input from Goulburn-Murray Water (G-MW), the Victorian Planning Authority (VPA) and the Goulburn Broken Catchment Management Authority (GBCMA), Spiire Australia Pty Ltd developed a masterplan layout for the site. The layout was then used to modify the topography within the flood model to represent residential areas (to be filled above the 1% AEP flood level), roadways inundated to no more than 0.30 metres and open space/drainage infrastructure to compensate for the infill of residential development.

The results of the proposed development conditions were compared to the existing conditions. The flood modelling showed that if the initial masterplan was implemented, it would result in unacceptable flood level increases in areas upstream and downstream of the study area.

Several revisions of the masterplan were developed and re-run within the flood model to demonstrate the revised layout achieved an acceptable outcome with regards to managing riverine flood risk and no increase in flood levels outside of the site. The revised masterplan sought to strike a balance between the level of development and flood risk management for the safety of the community and future sustainable development.

The final modelled layout (Figure 2) provided additional floodplain storage, based on a loss of 83,000m^3 of floodplain storage through the raising of residential areas above the 1% AEP flood level and roadways to within 300-500 mm below the 1% AEP flood level but compensated with around 195,000 m^3 of floodplain storage through two basins and the main east-west drainage easement.

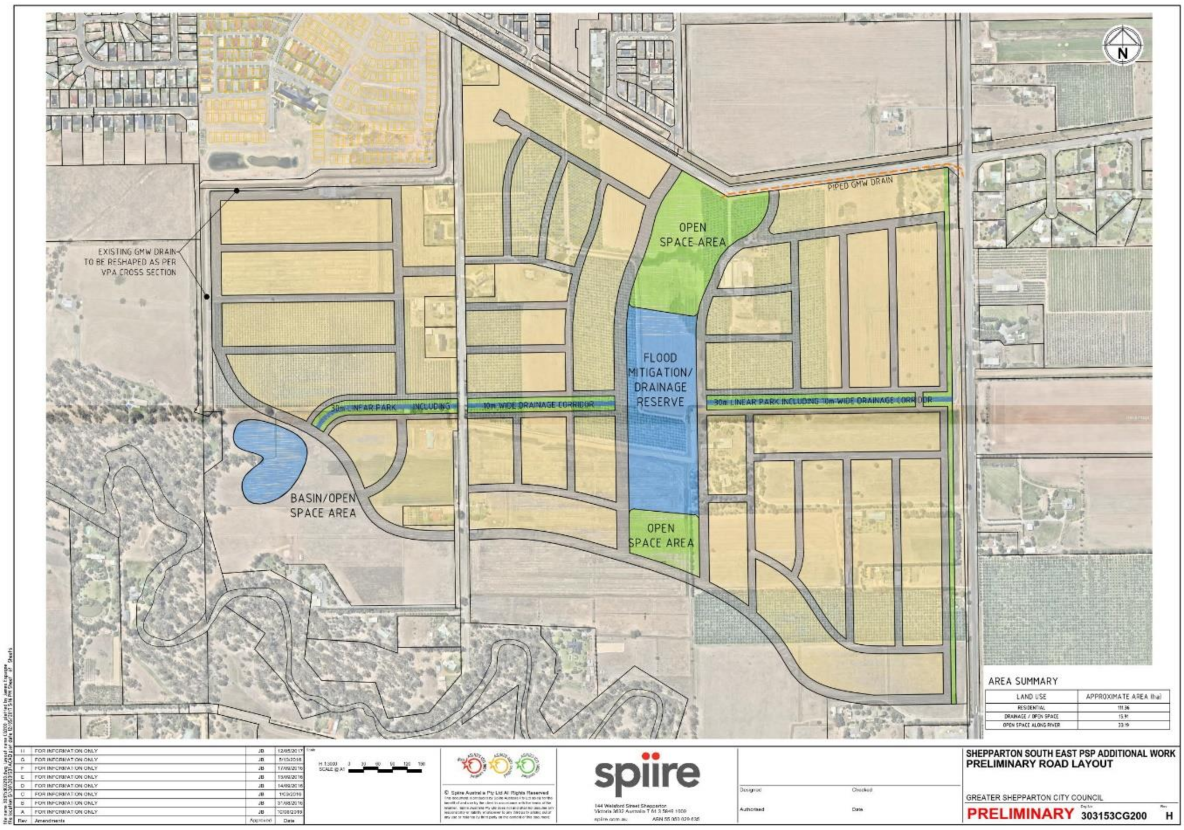

Figure 2 Spiire Concepts Plan – Indicative subdivision layout for modelling purposes only

1.2 Revised Development Layout

Following the completion of the 2018 flood modelling, Alluvium was engaged by GSCC and VPA to undertake a surface water drainage assessment as part of the PSP process. Through this process, a revised layout to provide more developable area was investigated. The revised layout is shown in Figure 3.

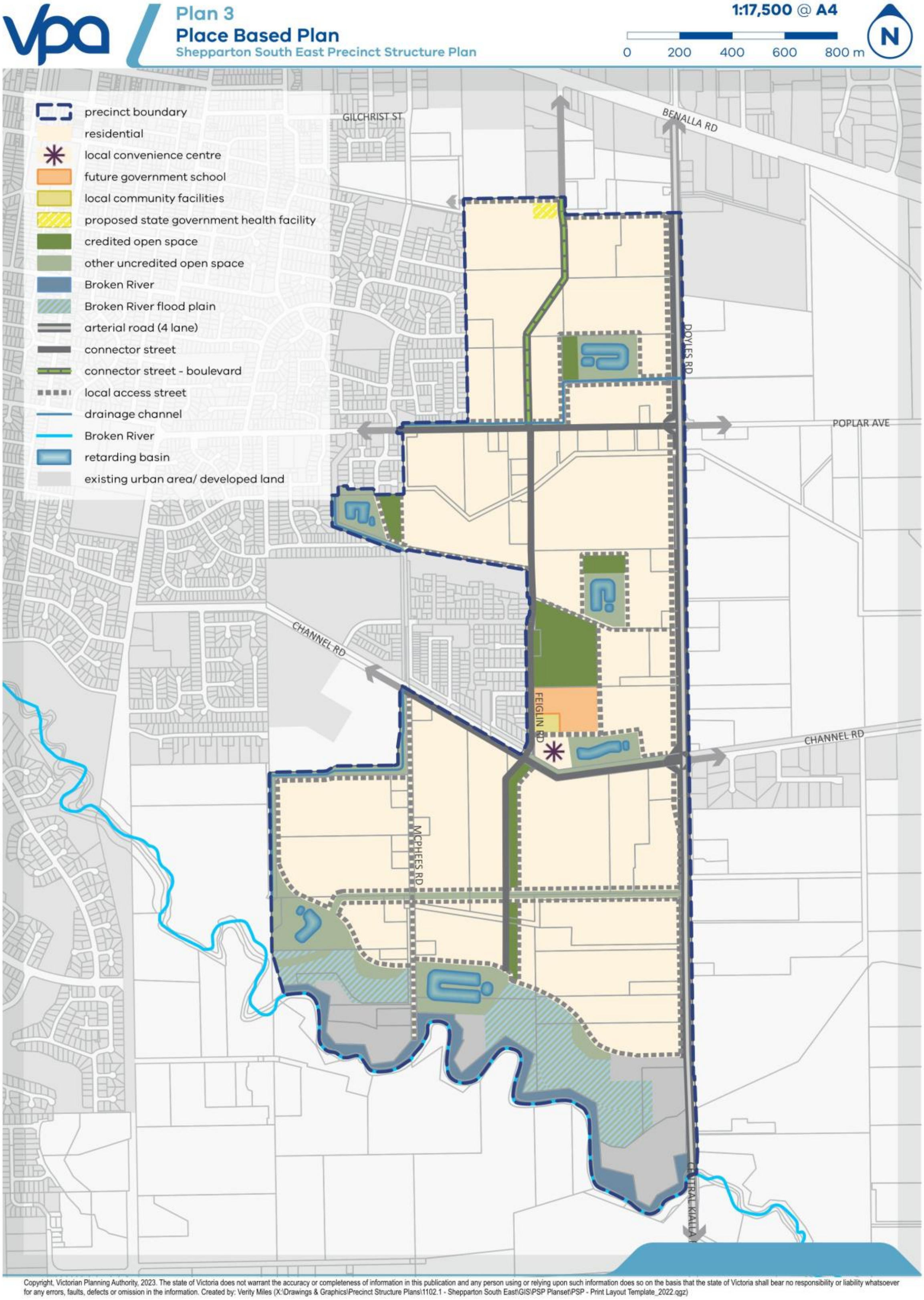

Figure 3 Updated Shepparton South East PSP Layout (2022)

2 1% AEP FLOOD CONDITIONS

The 1% AEP flood modelling results from the Shepparton Mooroopna supplementary mapping project were used as the primary assessment tool for the Shepparton South East PSP. This was based on a 1% AEP event on the Broken River which produces a flood level of 12.1m at the Shepparton streamflow gauge. The 1% AEP flood depths are shown in Figure 4.

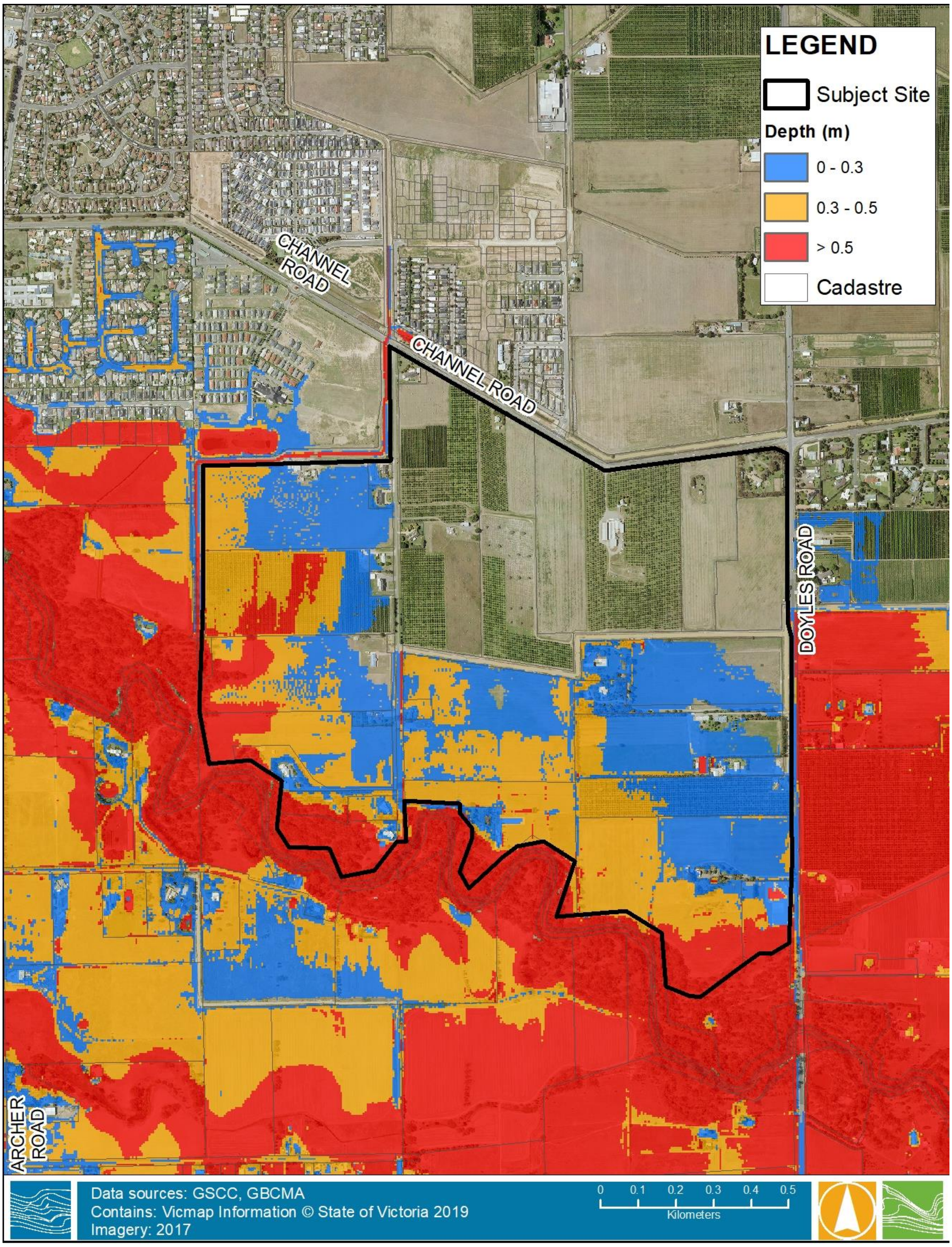

Figure 4 1% AEP – Existing Conditions Depth Plot

3 1% AEP CLIMATE CHANGE CONDITIONS

The 1% AEP climate change flood modelling results from the Shepparton Mooroopna 1% AEP Flood Mapping Project (2021)were used as a primary assessment for the Shepparton South East PSP. This was based on a Broken River dominant event which produces a flood level of 12.27m at the Shepparton streamflow gauge. On average there are increases in the flood depth through the study area of around 150-200mm. This has the potential to reduce the 'Net Developable Area' by increasing a significant portion of the study area into depths greater than 300mm and also above 500mm in some cases, while also increasing the overall quantum of earthworks (related to increased fill levels) as well as potential access/egress issues.

Discussions with GBCMA have suggested that greenfield development should not be located where flood depths exceed 300mm in existing conditions and 500mm under the climate change scenario. It is suggested that fill levels of developable lots within the study area be filled to the 1% AEP climate change flood level and a Finished Floor Level (FFL) be 300mm above this level.

Access and egress levels may also be required to adopt a more lenient level when assessing climate change modelling results as opposed to existing conditions results. The 1% AEP climate change depths are shown in Figure 5.

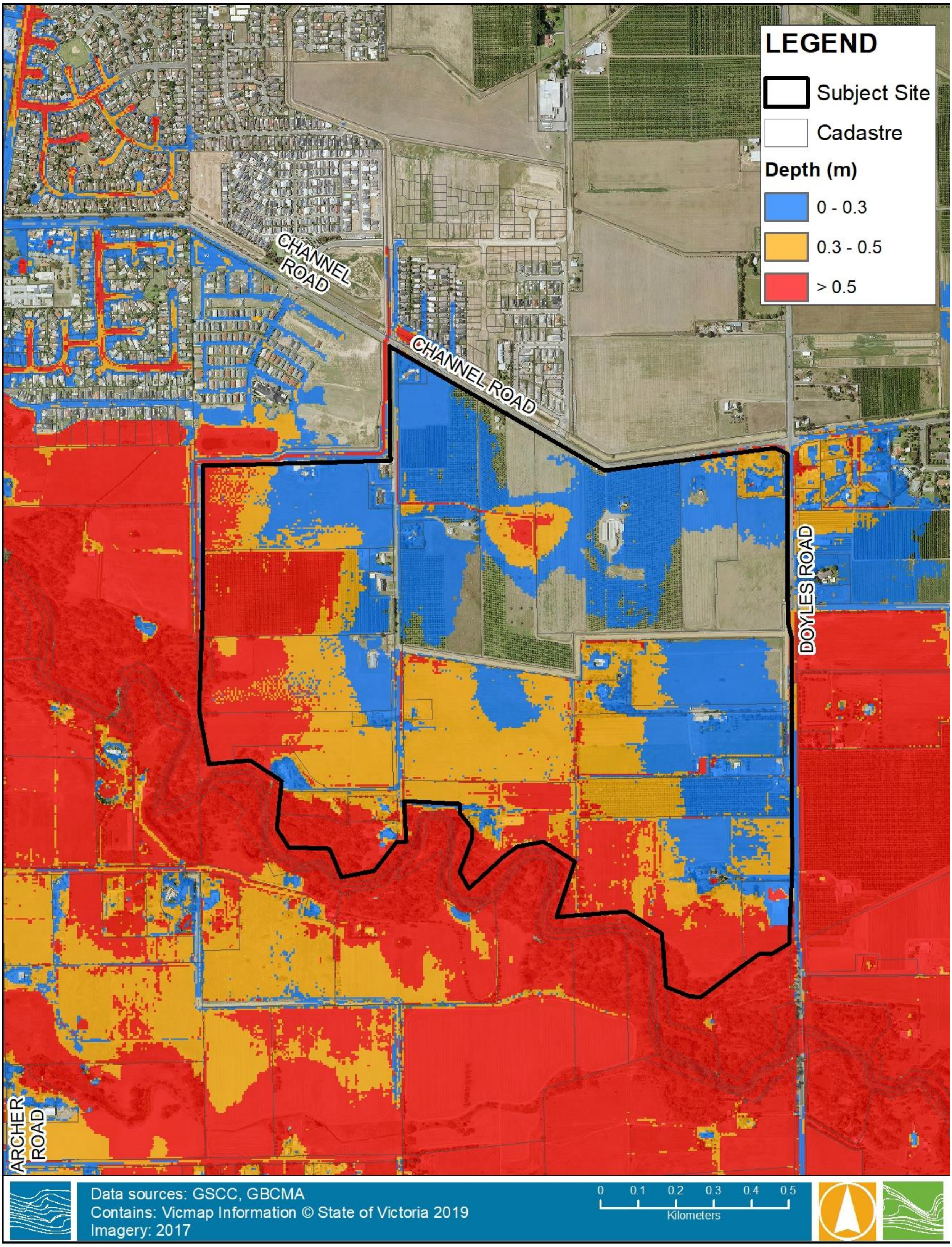

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Figure 5 1% AEP – Climate Change Depth Plot

4 REVISED DEVELOPMENT FLOOD IMPACT ASSESSMENT

Two development footprints entailing the revised layout were modelled for the 1% AEP with climate change flood event. Both options generally maintain the footprint outlined by Spiire (2018) and Alluvium (2022) which brings flows into the site via a set of culverts under Doyles Road through to the centre of the site.

- The two options differ in the overland flow path running through the site.
- The first option assessed branches the overland flow path from the centre of the site south before connecting with the Broken River Floodplain.
- The second option continued west through the site rather than branching south towards the Broken River floodplain.
- The resultant flood depth plots are shown in Figure 6 and Figure 7.

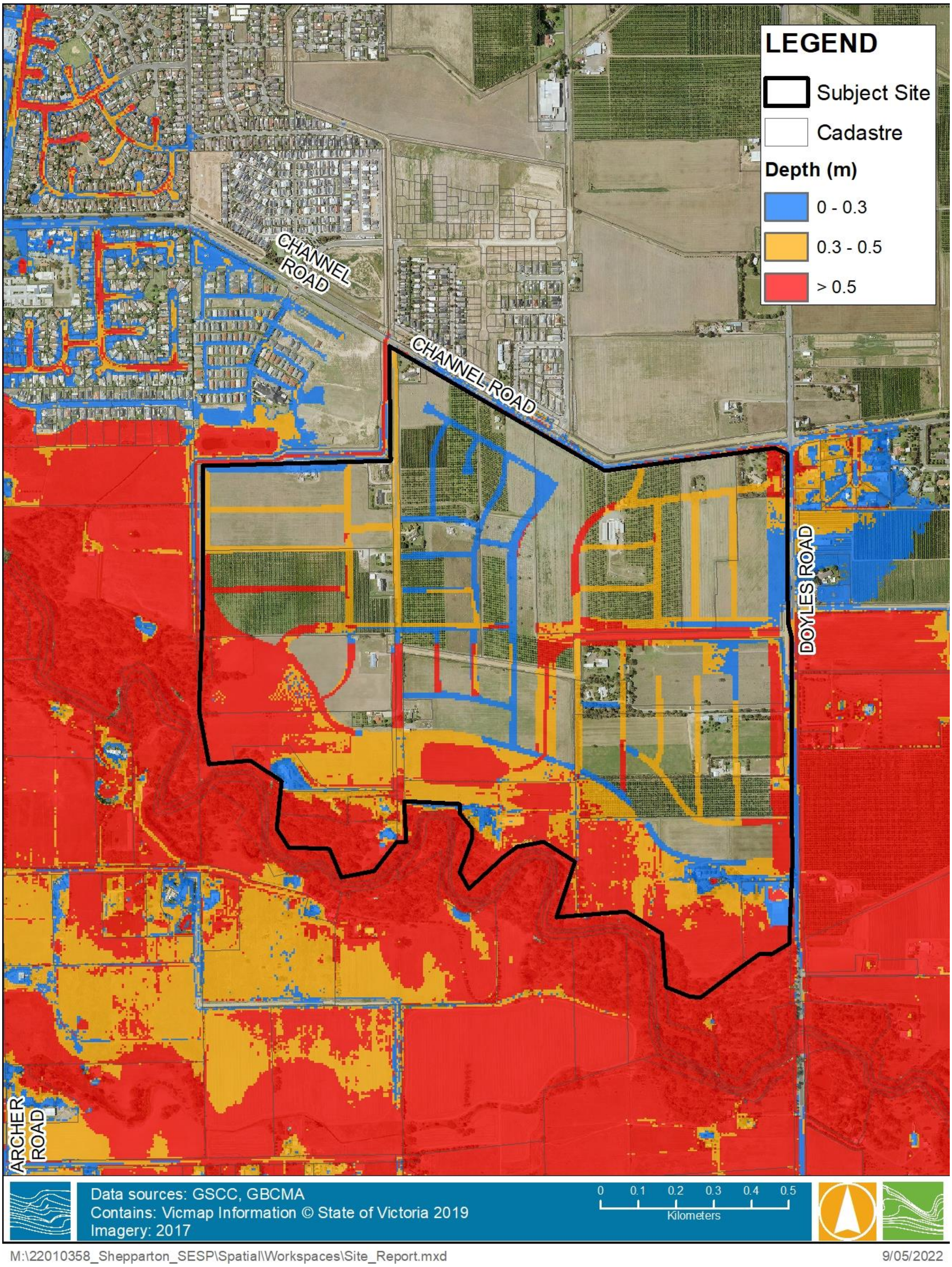

Figure 6 Development Option 1 – Flood Depth (1% AEP with Climate Change)

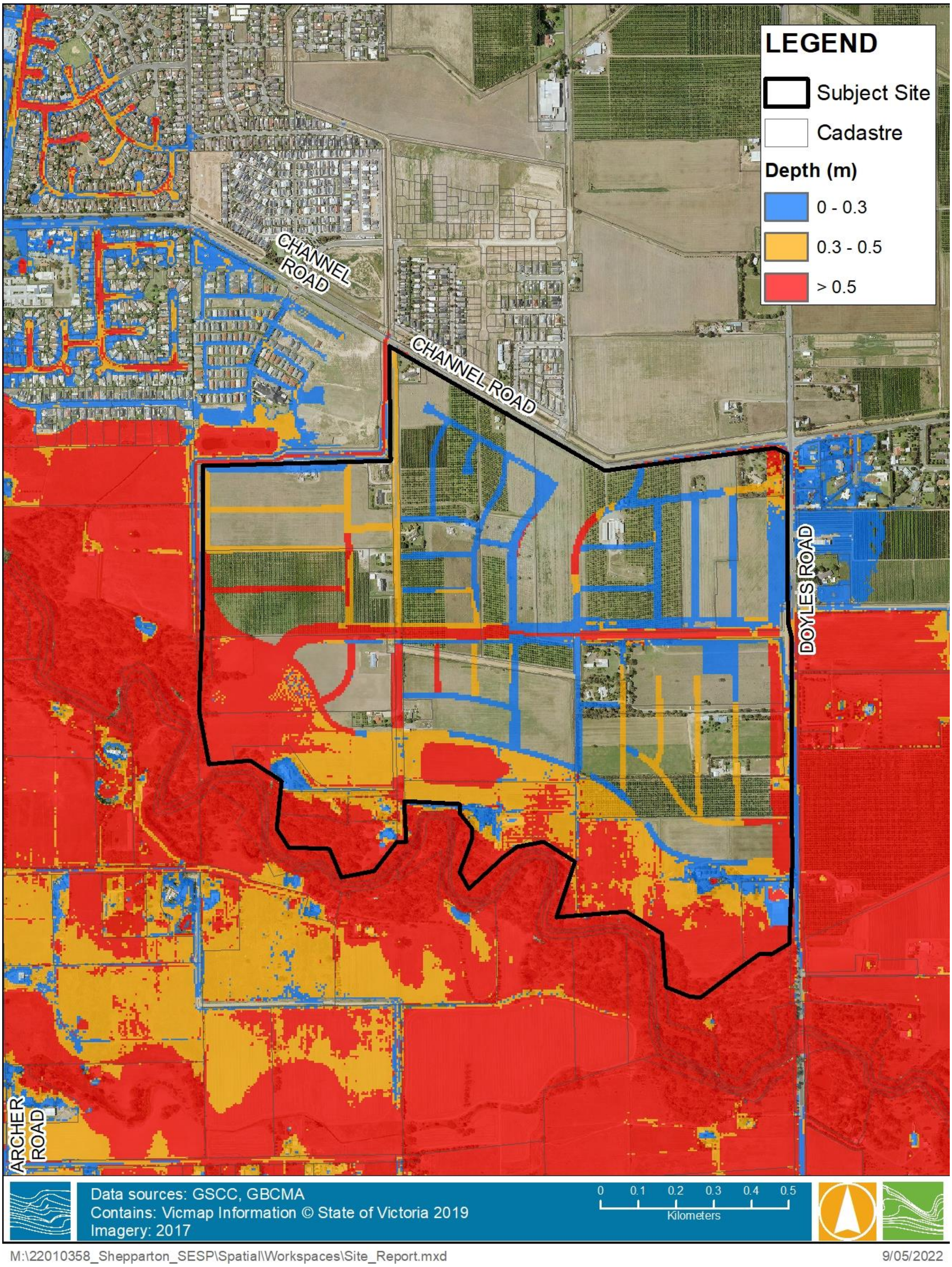

Figure 7 Development Option 2 – Flood Depth (1% AEP with Climate Change)

4.1 Flood Level Impact

To understand the impact the development would have on flood levels, depths and extents a direct comparison was drawn between the Water Surface Elevation (WSE) predictions from the 'Base Case' and 'Developed' models. This comparison is calculated as follows:

Developed WSE – Base Case WSE = Difference in predicted WSE

This comparison shows the impact of the development in terms of a change in WSE. A positive change indicates an increase in WSE post development for the 1% AEP with climate change flood event. A negative change indicates a decrease in WSE after development during the 1% AEP with climate change flood event. The comparison also shows areas which were previously inundated and are now dry after the development and areas which were dry and are now inundated. The two resultant flood level difference plots are shown in Figure 8 (development option 1 – north-south flow path) and Figure 9 (development option 2 – East-West flow path).

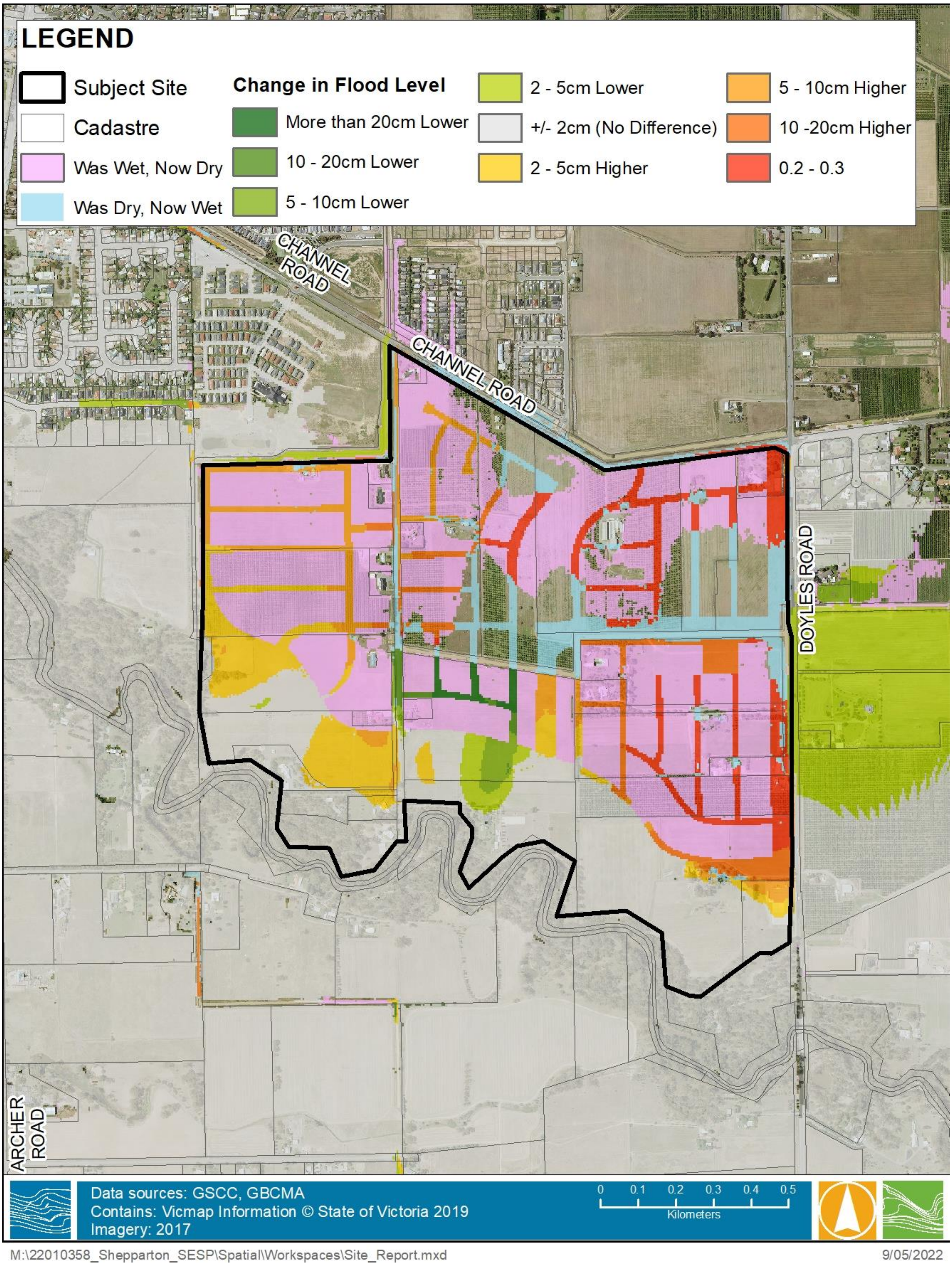

Figure 8 1% AEP Flood Depth Afflux – Development Option 1

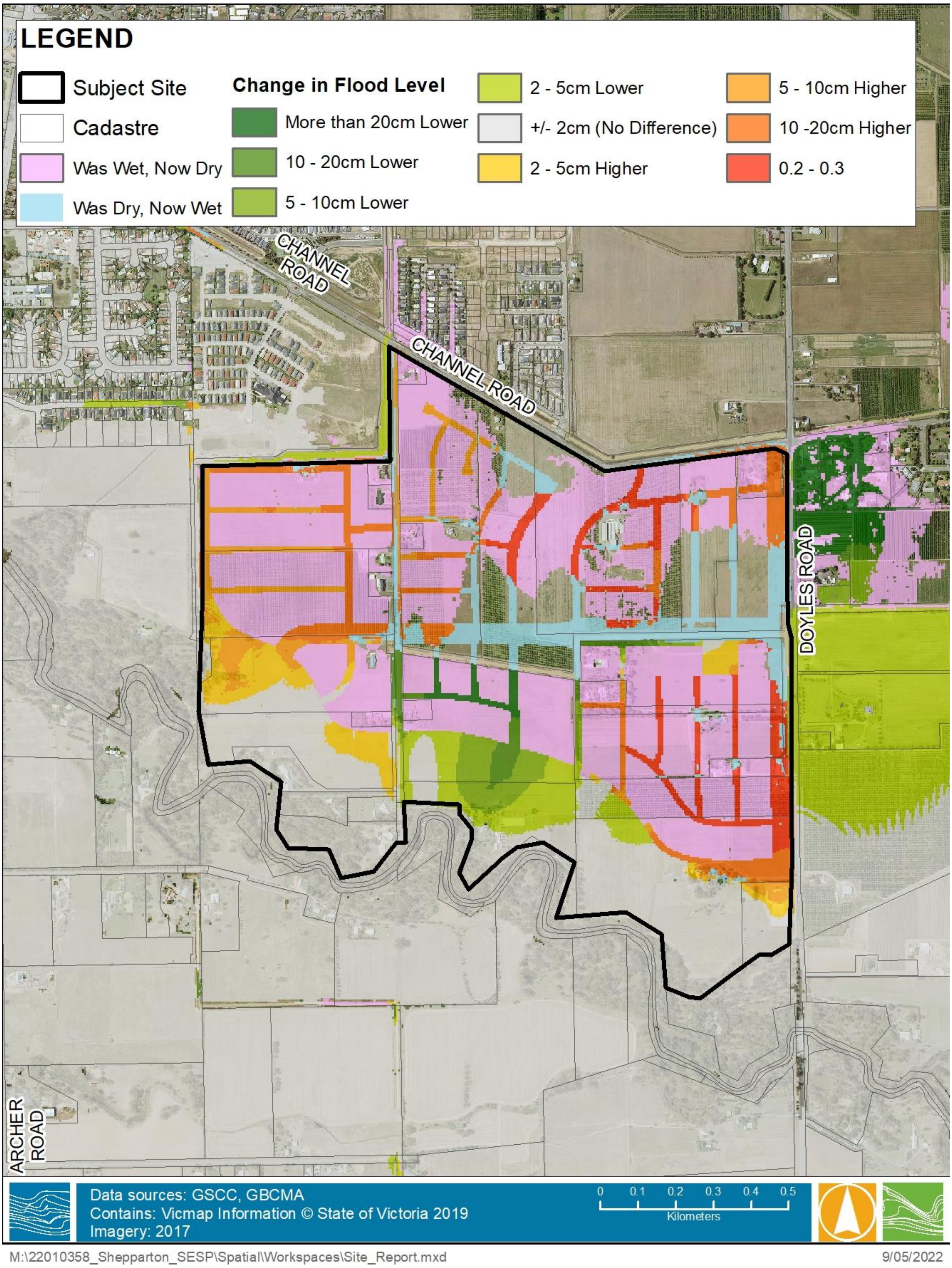

Figure 9 1% AEP Flood Level Afflux – Development Option 2

5 EARTH WORKS AND FLOODPLAIN STORAGE

5.1 Earthworks

The proposed development scenario relies on filling of the site to above the 1% AEP (with climate change) flood level. This requires significant fill volumes to be imported into the development precinct. This can be somewhat offset by 'cut' taken from within the site

The finished levels used for the flood modelling are not final design levels and are based on a grid resolution of 5m x5 m. These are indicative only and are used to provide an estimate of total earth works required. Cut and fill values quoted are likely to change slightly at a further detailed design stage and would also change once final road levels are included in the design.

The total cut and fill calculated from the two final development layouts are shown in Table 1. This shows there is a need to import around 370,000-420,000m^3 of fill based on assumptions that the modelled scenario is adopted.

These calculations do not incorporate the floodplain storage requirements, which is discussed further below.

Table 1 Cut Fill Earthworks Summary

Development Option	Fill Required (m^3)	Cut Required (m^3)	Net Balance (m^3)
1	580,000	160,000	420,000
2	550,000	180,000	370,000

5.2 Floodplain Storage

Typically, the GBCMA would require that any loss of floodplain storage be compensated in a 1:1.3 ratio for a single private development. Given the size of the development being undertaken, it is understood the GBCMA will assess floodplain storage requirements on a 1:1 ratio. It is also assumed that provided flood the mapping shows no significant afflux outside of the site, negotiations into an acceptable reduction in floodplain storage may result in this requirement being waived.

A summary of the loss of floodplain storage (based on a 1:1 ratio) is shown in Table 2. This shows that Development Option 1 provides an additional 7,000m^3 of storage while Development Option 2 has a reduction of around 5,000m^3. This equates to around 0.8% of the total volume stored within the precinct under existing conditions.

Table 2 Floodplain Storage Calculations

Floodplain Storage	Existing Conditions (m^3)	Development Option 1 (m^3)	Development Option 2 (m^3)
1% AEP Climate Change	637,675	645,001	632,328
Net Balance		+ 7,327	- 5,347

6 DISCUSSION

The development footprint assessed in this investigation is generally in line with the previous work assessed in 2018. It is important to note, the east-west floodway through the site from Doyles Road has been shown to be an important hydraulic control in maintaining conveyance and flood levels throughout and upstream of the site at existing conditions levels. The flood conveyance across the site was maintained by locating residential areas to be filled away from the main flow paths of the Broken River floodplain across the south of the site.

6.1 Potential Flood Risk with Development

Modelling of flood behaviour developed by Water Technology has shown that areas within the Shepparton South East PSP site may be suitable for residential development from a floodplain management perspective. The updated design has considered suitable drainage requirements from stormwater generated within the site.

6.1.1 Flood Warning Time

The study site has considerable flood warning time from a riverine flood from the Broken River. There are currently a number streamflow gauges on the Broken River including Orrvale, Gowangardie, Benalla and further upstream at Lake Nilma. These gauges provide a good indication of expected peak flooding as well as estimated flood levels at the Orrvale gauge and the study site.

Flood peak travel times from the gauge upstream of Benalla to the Orrvale gauge is estimated at 24 to 48 hours based on historical floods including 1993, 1995 and 2010.

6.1.2 Site Egress

Channel Road and Doyles Road, the main entry and exit routes to the development, appear to provide sufficient egress during a 1% AEP flood event. As mentioned above, there is a long flood warning time (1-2 days) prior to the flood peak arriving at the site. Velocities resulting from the Broken River flood event are not excessive, with isolated areas with potentially high velocities limited to within the floodplain storage basins on site. The relatively flat terrain does not result in significant areas of high velocity in a 1% AEP Broken River flood event across the site proposed for development.

6.2 Open Space

Currently, areas designated for residential development and open space have been raised above the 1% AEP flood level. This was based on instruction from VPA and GSCC. This requirement has resulted in an increase in fill to be imported into the site to provide unencumbered (flood free) open space. There may be opportunities to reduce the volume of fill required by allowing some of the open space to be inundated during rare flood events.

7 CONCLUSION

Based on the results from the existing flood development plan and through several iterations of the development footprint provided by VPA through Alluvium, two development layouts have been provided that show negligible afflux outside of the site in a 1% AEP (with climate change) event.

Both options show significant earthworks are required with importation of fill volumes in the order of 350,000 – 420,000m^3. Both scenarios also show there is a relatively minor change in floodplain storage in the 1% AEP climate change event, with an additional ~7,000m^3 of storage in Development Option 1 while Development Option 2 has a reduction of around 5,000m^3.