GoldenPlains
WIND FARM MANAGEMENT PTY LTD

Golden Plains Wind Farm

Appendix C.8: Surface Water Impact Assessment

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Surface water impact assessment

Golden Plains Wind Farm

Golden Plains Wind Farm Management Pty Ltd

25 November 2020

Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
1	Draft	Ben Hughes	Ben Hughes	11/09/2020
2	Draft	Seb Barriere	Ben Hughes	13/11/2020
3	Final	Seb Barriere	Ben Hughes	25/11/2020

Project Details

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Document Number	21010100_R01v02b_GPWF_update.docx

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25 November 2020

Kyle Sandona
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Via email kyles@w-wind.com.au

Dear Kyle,

Golden Plains Wind Farm

This report is intended to supplement the surface water assessment which supported the Environmental Effects Statement (EES), by providing a concise assessment of the revised wind turbine layout provided on November 12th, 2020. This work includes a flood risk assessment of the revised turbine and road layout, considering the existing flood modelling already completed.

Yours sincerely

Sebastien Barriere
Senior Engineer

Sebastien Barriere

WATER TECHNOLOGY PTY LTD

EXECUTIVE SUMMARY

This report documents the flood risk assessment of the revised WTG layout which has seen the number of WTG sites reduced from 228 to 215.

The WTG sites, access roads and other works have been assessed with regards to flood risks using the hydraulic model results of the 1% AEP flood event developed for the EES.

All turbines have been located a minimum of 100 m from any of the four major waterways that intersect the site and no less than 30 m from smaller intermittent streams. This satisfies permit condition 82 and 83.

The modelled results for the 1% AEP flood events on the four waterways intersecting the Project site indicate there are three turbine locations (with associated hardstands) impacted by floodwaters, in both the flood fringe and active floodplain (depth > 300mm). The cut-and-fill requirements have been calculated based on the loss of floodplain storage corresponding to the hardstands built above flood level, and equate to 3,530 m^3. Given the shallow depths and slope of the topography, the proposed wind turbines and associated infrastructure are unlikely to impact on floodplain storage and downstream flood levels (permit condition 85.a and 85.b) and the overall impacts on flooding have been reduced when compared with the impacts assessed under the EES (seven turbine locations were impacted by waterway flooding with the initial layout).

Furthermore, the assessment of site runoff has shown that four turbine locations would be subject to inundation along some of the flow paths activated during intense rainfall. Modelling results indicate water depths above 100 mm for the 1% AEP event are to be expected in those four locations. These impacts are less than the impacts assessed under the EES (seven turbines were impacted by local runoff) and can be managed through detailed design and in the Construction Environmental Management Plan as envisaged by the Permit conditions.

Waterway crossings require a Works on Waterway Permit from CMA. The Permit will require crossings are designed adequately for any infrastructure that intersects a waterway (i.e. fords/culverts that do not impede flow), hence the proposed wind farm will not alter the hydrology of the waterways (permit condition 85.c). Appropriate treatment of surface water runoff carrying increased sediment load during the construction phase will be required and can be appropriately managed through the Construction Environmental Management Plan.

It has been brought to our attention that the Project is seeking approval to use a larger turbine rotor than initially proposed; however, we understand the size of foundations and hardstands won't change, hence this will not modify flood behaviour on site from the assessment for the EES.

It is Water Technology's opinion that the overall flood risk of the site has not changed significantly, and in many cases has been improved. We do not believe that the revised layout will have any adverse impacts beyond that of the original layout considered in the Environment Effects Statement.

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1 INTRODUCTION

Water Technology finalised a report in February 2018[1] providing an assessment of the potential surface water considerations associated with the construction, operation and decommissioning of the Golden Plains Wind Farm (the Project). It also addressed the movement and distribution of water (flooding), and water quality for the purpose of the Environment Effects Statement (EES).

The methods employed in the development of the surface water assessment included:

- Review of existing surface water information.
- Assessment of catchment flood behaviour, through hydrology and hydraulic modelling of the waterways in and around the Project Site.
- Assessment of drainage paths through hydrology and hydraulic modelling of rainfall directly on the site.

The layout of the Projects infrastructure has since been revised and the surface water assessment was reviewed to take into account the changes in turbine locations and access track alignments.

It is understood that the 228-turbine layout assessed under the EES has been reduced to 215 turbines. The revised surface water assessment documented in this report considers the existing flood modelling already completed, and focusses on the following aspects:

- The change in impact (if any) to surface water as a result of the 215-turbine layout when compared with the 228-turbine layout included in the EES.
- The permit conditions relating to surface water matters (Conditions 82 –85).
- Permit condition 85c regarding construction and decommissioning, to ensure that there are no material impacts to overland flow regimes beyond the external boundary of the wind farm.

[1] 5390_R01v08_SurfaceWaterAssessment.docx, Water technology, 2018

2 REVISED LAYOUT

The revised wind farm layout ('215 WTG Layout') contains 215 turbines as opposed to the 228 turbines proposed in the original Project layout ('228 WTG EES Layout'). The turbine locations and associated access tracks are presented in the figure below. For comparison the previous layout is also presented in Figure 2-1.

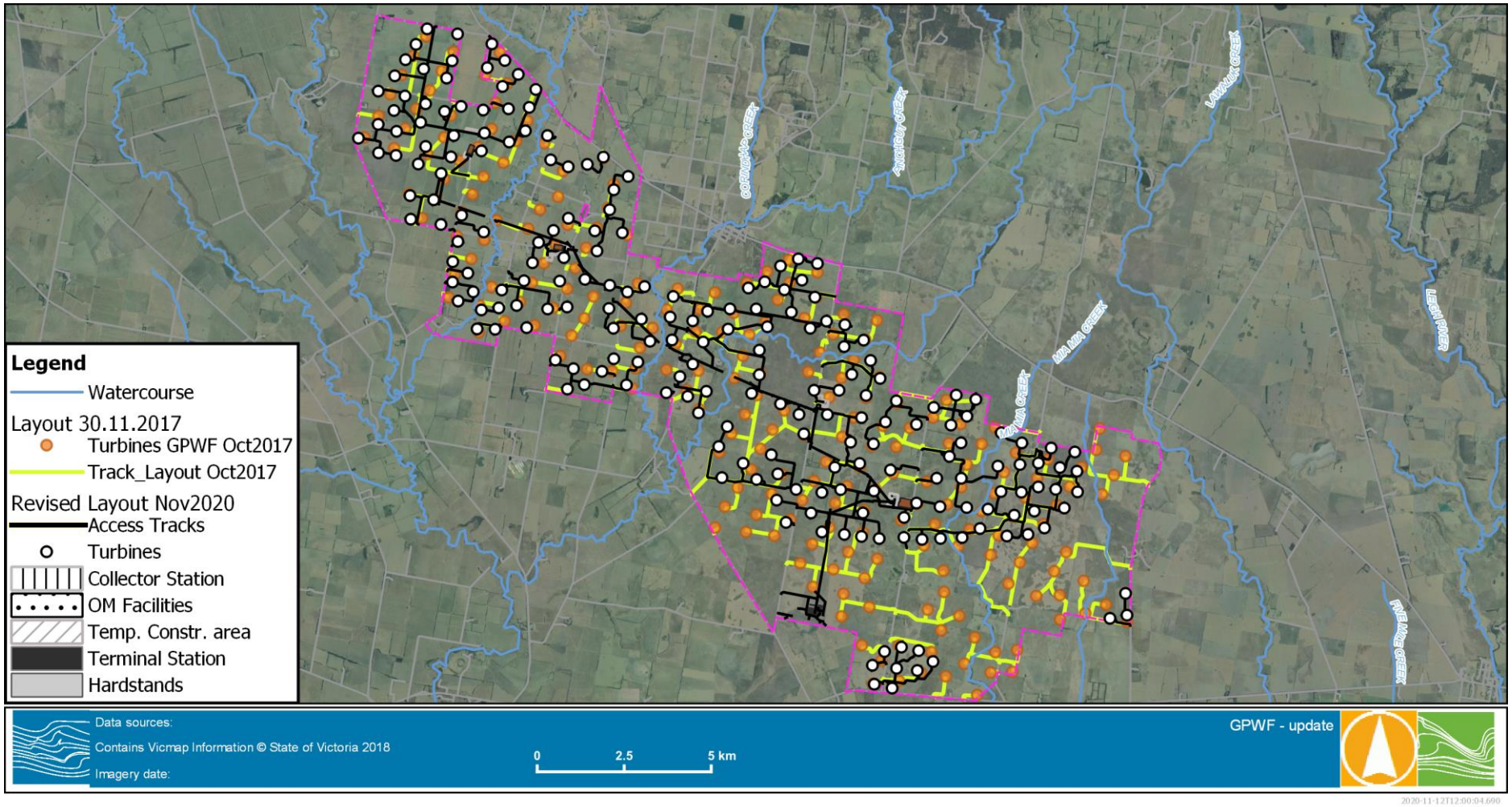

FIGURE 2-1 REVISED (215 WTG) AND PREVIOUS (228 WTG) WIND FARM PROPOSED LAYOUTS

3 SURFACE WATER ASSESSMENT

The surface water assessment investigated the flood risk from two sources of flooding, the four major waterways that intersect the site (catchment flood behaviour), and inundation caused by direct rainfall on the site through local runoff from the intermittent waterways (site runoff).

Catchment flood behaviour was assessed by developing a rainfall-runoff model in the software package RORB, which was calibrated to historical events. The resulting hydrographs were used as inflow boundaries to a hydraulic model, to assess the resulting flood extents.

Implications of rainfall directly on the proposed site was assessed by developing a separate rain-on-grid (or direct rainfall) hydraulic model.

The revised layout has been overlayed to the previously calculated flood extents and the likely impacts on flood risk documented here-after. For more details on the hydrology analysis or hydraulic model development please refer to Surface Water Assessment completed in February 2018 (Water Technology).

FIGURE 3-1 WIND FARM SITE AND WATERWAYS

3.1 Catchment flood behaviour

The modelled results for the 1% AEP flood event under existing conditions along the four waterways intersecting the Project site, indicate there are three turbine locations impacted by floodwaters, in both the flood fringe and active floodplain. The locations of these turbines are discussed in detail below.

As shown in Figure 3-2, WTG048 and WTG037 are located within the flooded extent along a breakaway flow path from the left bank of Mt Misery Creek, it should be noted that water flows around WTG037 and only the southern edge of the hardstand is impacted. Under existing conditions water depths do not exceed 300 mm around the hardstands. The very shallow water depths indicate the proposed design will have a negligible impact on the floodplain storage along Mount Misery Creek at sites WTG048 and WTG037. These hardstands would only require a slight raising in levels to be above the 1% AEP flood level. The loss of storage volume is approximately 1,470 m³.

Turbines WTG090 and WTG095 are proposed to be located in areas of slightly deeper flood water, along Kuruc-A-Ruc Creek. With the raising of the hardstands to above the 1% AEP flood level, the loss of storage volume is approximately 2,050 m³.

It should be noted the volumes calculated above correspond to the overall impacted area of works around the turbine foundations and hardstands (i.e. including road extents and crane assists), they likely are a conservative estimate of the loss of floodplain storage. This is however negligible compared to the overall volume put to contribution in the floodplain during a flood event. No observable impacts on flood levels outside of the immediate vicinity of the aforementioned sites is expected.

The turbines impacted by floodwaters are summarised in the table below.

TABLE 3-1 IMPACTED TURBINE LOCATION DURING 1% AEP FLOOD EVENT ON WATERWAYS

Turbine	X	Y	Water level (mAHD)	Water Depth (m)
WTG048	732691.1	5799867	163.310	0.134
WTG095	736603	5797799	154.213	0.331
WTG090	736275	5797142	151.965	0.065
WTG037 (hardstand only)	731984	5798751	157.302	0.105

In addition to the turbines, four sections of access tracks cross overland flow-paths, including an area of overbank flooding on the left bank of Mt Misery Creek and one crossing of Ferrers Ck.

This overtopping occurs just upstream of Gilletts Rd. Gilletts Rd and Mill Road will also be overtopped during a flood event of this nature as water flows to the south.

Compared to the previous layout, access tracks and turbine locations have been changed slightly but still occupy areas within the flood extent. Access tracks to GP0028, GP029 and GP033 which ran perpendicular to the flow-path have been replaced by access tracks to WTG037, WTG046, WTG038 and WTG048 and present similar, acceptable flood risks given the shallow depths that can be managed via standard engineering controls (see Figure 3-2).

Along Kuruc-A-Ruc Creek, hardstands and access tracks between WTG095 and WTG090 are impacted by floodwaters. Water depths locally exceed 300 mm, but once again these impacts can be managed via standard engineering controls

Compared to the previous layout submitted as part of the EES, turbine locations have been moved further out of the inundated area, closer to the flood extent limit (see GP073 and GP074 in Figure 3-3 as well as GP079 and GP082 in Figure 3-4), so the revised layout in this area presents a lower flood risk.

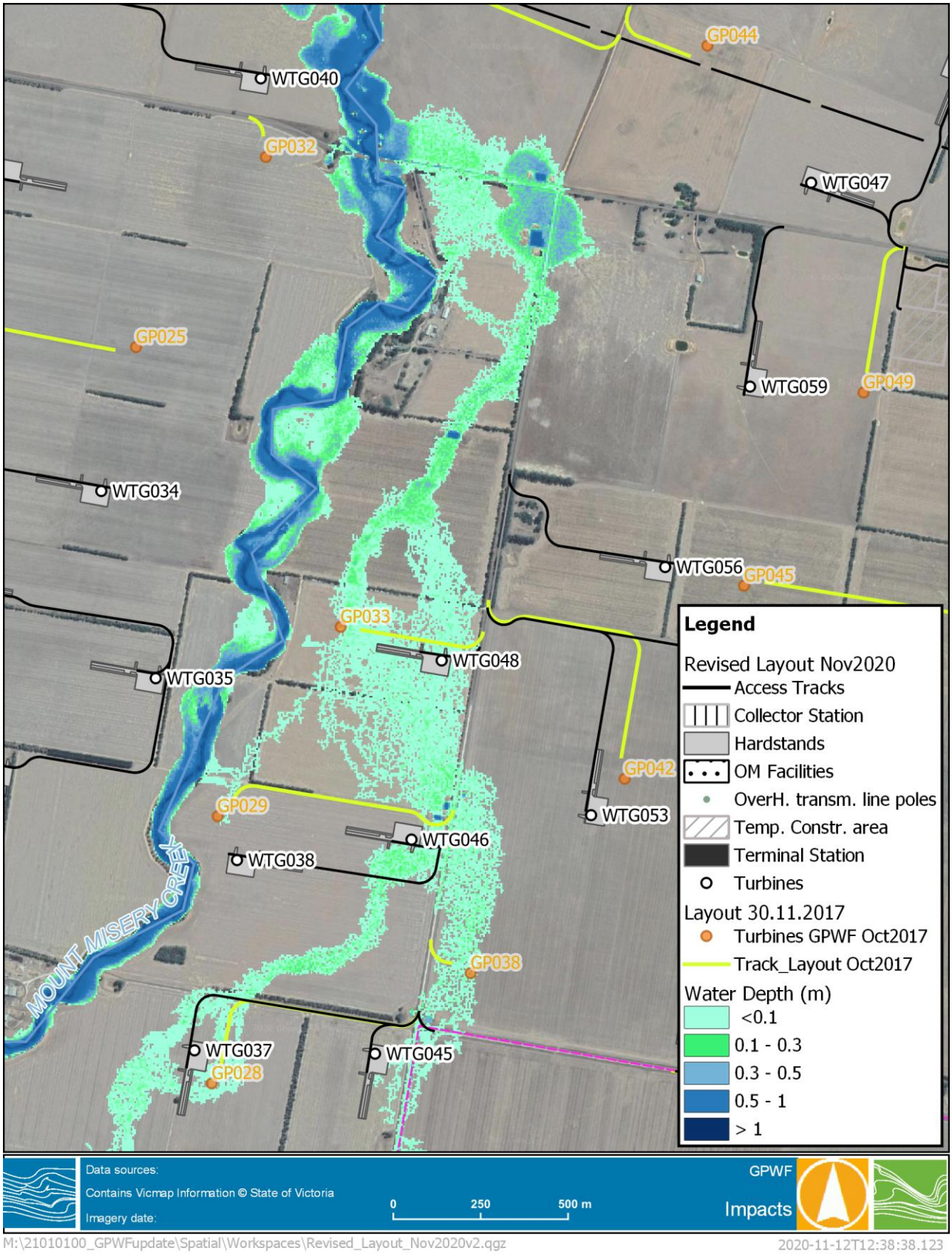

FIGURE 3-2 IMPACTED AREAS – 1% AEP EVENT ON MT MISERY CREEK

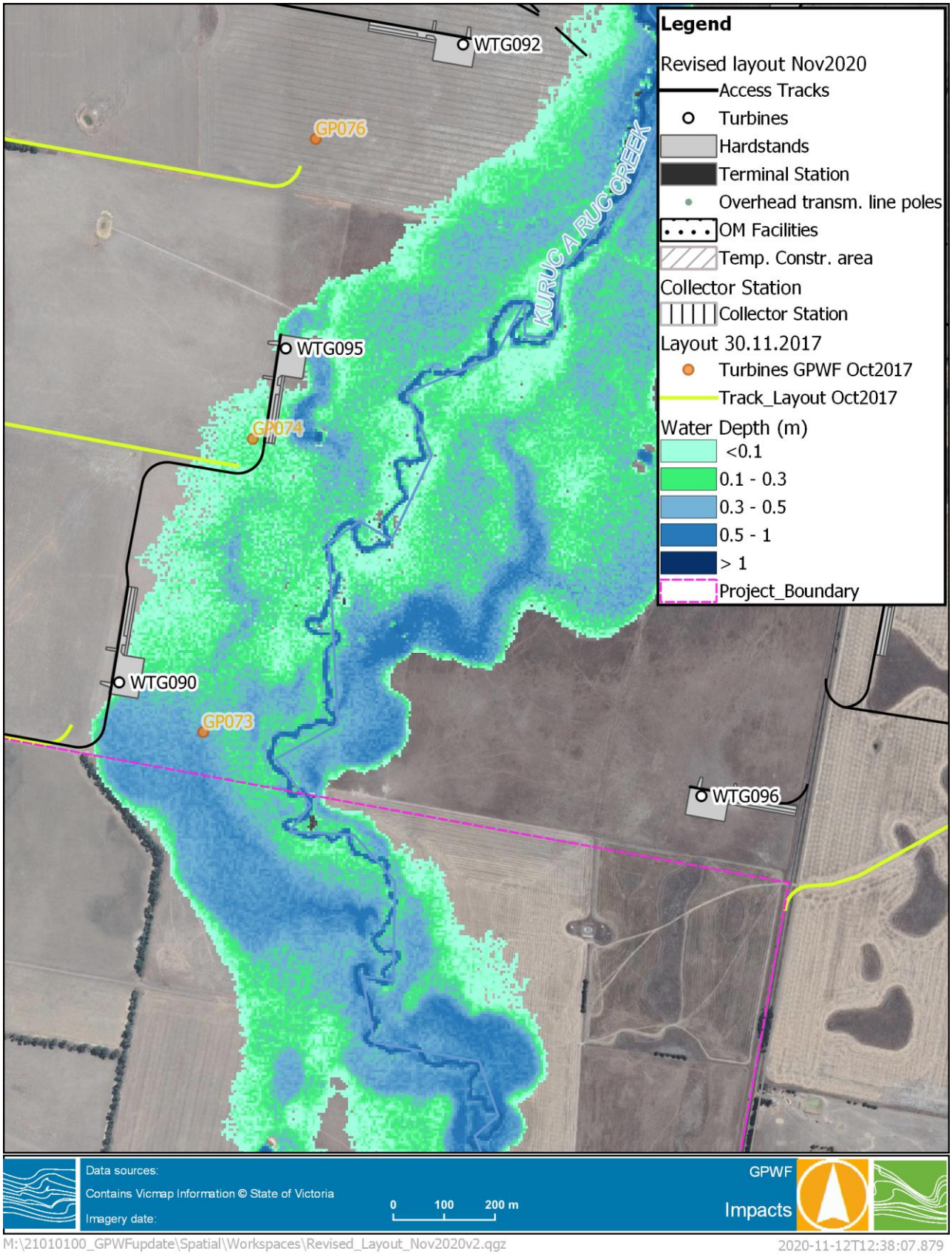

FIGURE 3-3 IMPACTED AREAS – 1% AEP EVENT ON KURUC-A-RUC CREEK

Flooding along the Ferrers Creek is relatively confined, with no turbine locations being impacted by flood waters. The access track between WTG118 and WTG105 crosses the Ferrers Creek channel. The capacity of the structure through the access track will need to be appropriately designed to avoid overtopping or not used during flood events. This crossing location is unchanged from the previous layout and dual access has now been provided for turbines across the creek, providing an alternative during flood events

In the previous layout, the access track between GP102 and GP106 crossed an inundated area on the right bank of Ferrers Creek. This track has been moved. The closest track to this location in the revised layout, between WTG121 and WTG112, is now located outside of the flood extent. Overall, the revised layout in this area presents a lower flood risk than the previous layout.

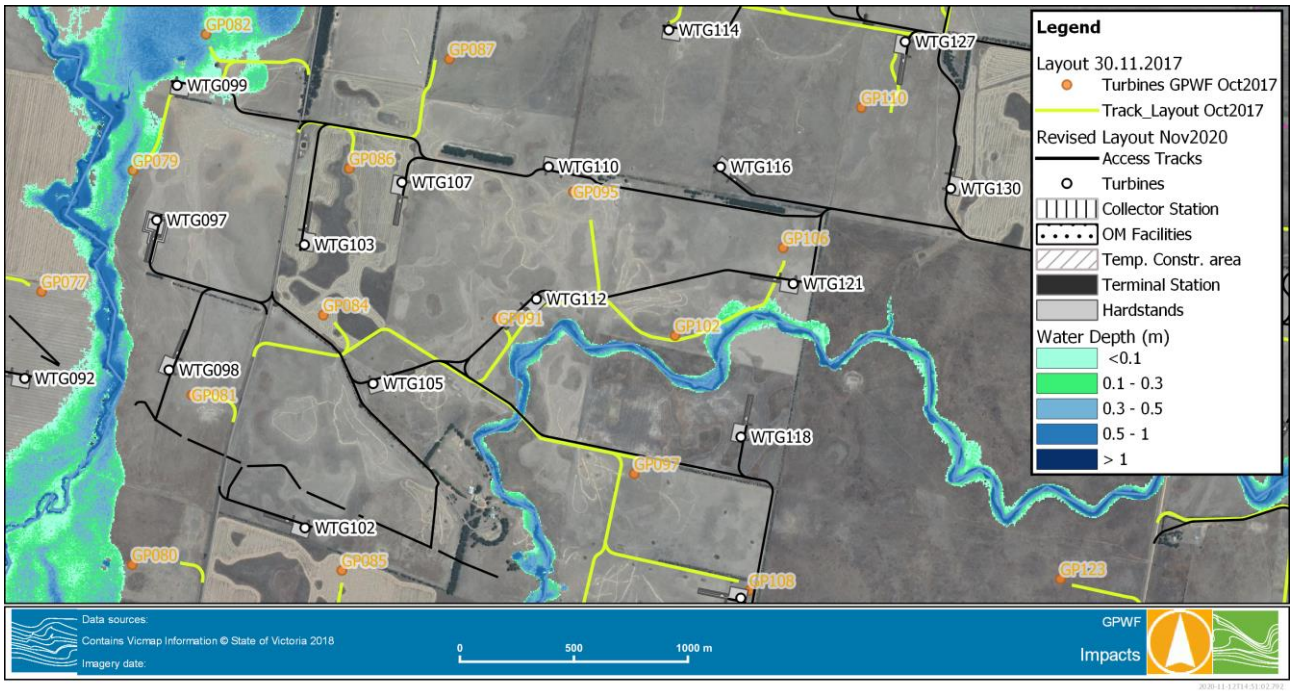

FIGURE 3-4 IMPACTED AREAS – 1% AEP EVENT ON FERRERS CREEK AND KURUC-A-RUC CREEK

3.2 Site runoff

The revised layout was overlayed on to the rain-on-grid model results which represent the flood risk posed by local overland flooding from an intense localised storm. The maximum water depth was extracted for the 1% AEP - 3hr storm event across the site. The overland flood depth at 15 out of 217 turbine locations has depths above 100 mm. However, the results indicate no turbines are located within large areas of significant ponding and it should be noted these values were extracted from a single point in the model. This corresponds to a 5m rectangular cell. For a better representation of the actual flood risk, the average flood depth across a 50 m radius around the turbine location was analysed, in order to filter out localised puddles as opposed to significant drainage paths. Results indicate only four turbines present depths above 100 mm in the surrounding 100m. The risk to these four remaining turbines can be adequately managed via engineering design and controls and through the development of a Construction Environmental Management Plan (CEMP) as contemplated by the Project's Planning Permit. It should be noted that with the initial layout of 228 WTG, seven turbine sites were impacted by floodwaters.

Furthermore, a number of locations intercept overland flow-paths. A total of 10 locations, either turbine hardstands and associated works or access tracks, are in the vicinity of flooding depths greater than 100 mm. These locations are described here-after.

Figure 3-5 presents the maximum depths obtained for the site runoff on the western part of the site. Access tracks near WTG015 and WTG020 (see near label WTG013 on map for location) cross a major overland flow-path with depths up to 500 mm locally. These crossings have slightly changed positions compared to the previous layout, however the total number of crossings along the flow-path was three and remains that total. These crossings are acceptable provided adequate engineering design and controls are implemented in accordance with the Works on Waterways Permit (when applied for) issued by the Corangamite Catchment Management Authority.

Areas around turbines WTG082, WTG084 and WTG089 are located along a drainage path. Appropriate drainage infrastructure will be necessary to maintain safe access during storm events.

Furthermore, it has been verified that none of the turbine foundations are located within 30m of intermittent streams as depicted in CMA's Designated Waterways layer. It should be noted that the CCMA layer has a horizontal error as they were mapped at 1 in 100,000 scale. Therefore, the stream alignment used for the analysis was based on the model results that are based on data at a higher resolution (5m grid).

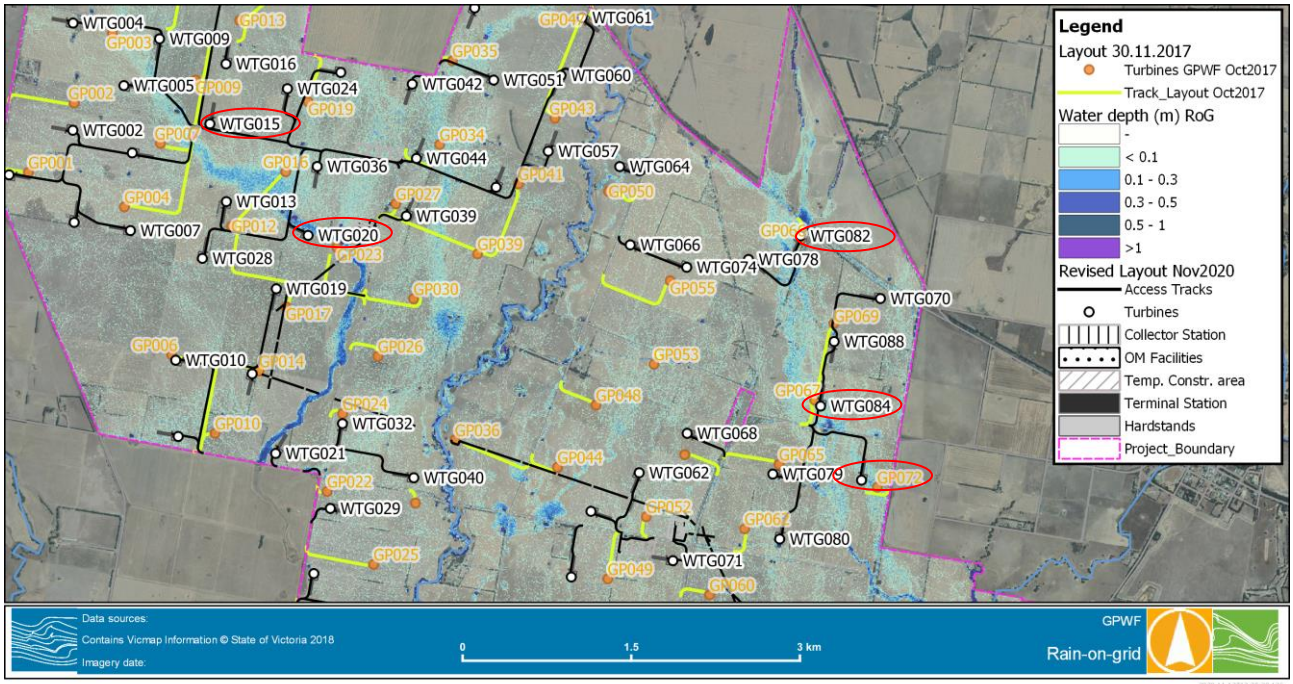

FIGURE 3-5 SITE RUNOFF – IMPACTED AREAS 1

Further West, the access track off Meadows Rd to WTG103 is in a flooded area with depths above 300 mm.

Along the flow-path that drains to Ferrers Ck from the north, the new position of tracks around WTG133, WTG127, WTG137 and WTG130 cross depths above 500 mm and are at risk of flooding. The area around WTG143 presents minor flood depths that will necessitate adequate drainage arrangements also.

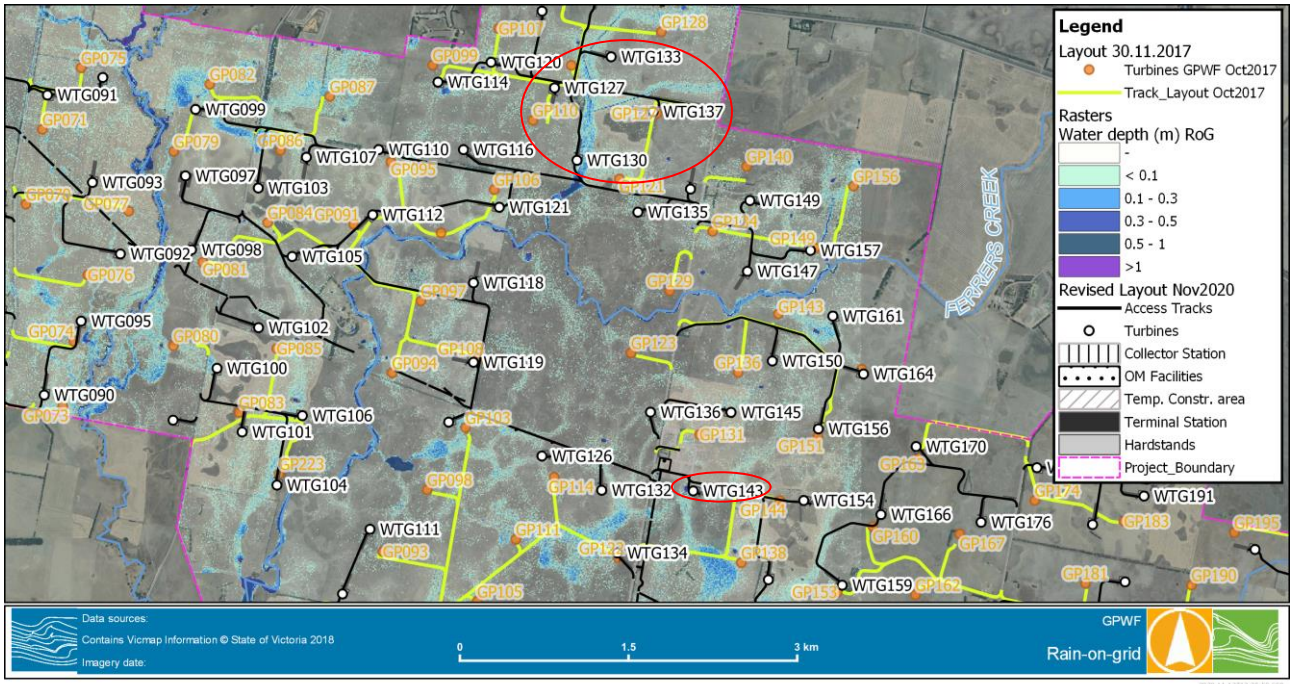

FIGURE 3-6 SITE RUNOFF – IMPACTED AREAS 2

WTG169 has been relocated close to Cressy-Shelford Rd and the model boundary. The modelled results close to the model boundaries are by definition uncertain given that boundary levels are forced (i.e. the boundary levels are set by the modeller) and may influence nearby results. While the calculated water depths reach up to 350 mm near the turbine location, it is likely that the water depths are overestimated, and the flood risk is minimal. It is recommended that for the detailed design the hydraulic model is updated and the boundary of the hydraulic model is moved further south in order to not influence calculations near the proposed infrastructure. None-the-less, engineering design and controls can be put in place as highlighted in previous sections of this report that will significantly reduce any flood risk to an acceptable level.

4 ASSESSMENT SUMMARY & FINDINGS

This report documents the flood risk assessment of the revised Project layout. The flood risk for the revised layout of 215 turbines has been investigated using the existing 1% AEP flood levels that have been derived from modelling for the four waterways with catchments upstream of the windfarm site, along with on-site drainage paths from direct rainfall-runoff.

All turbines have been located a minimum of 100 m from any of the four major waterways that intersect the Project Site and none are located less than 30 m from smaller intermittent streams. This satisfies permit condition 82 and 83.

The modelled results for the 1% AEP flood events on the four waterways intersecting the Project site indicate there are three turbine locations (with associated hardstands) impacted by floodwaters, in both the flood fringe and active floodplain (depth > 300mm). The cut-and-fill requirements have been calculated based on the loss of floodplain storage corresponding to the hardstands associated works built above flood level (catchment flood from waterways), and equate to 3,530 m³. Given the shallow depths and slope of the topography, the proposed wind turbines and associated infrastructure are unlikely to impact on floodplain storage and downstream flood levels (permit condition 85.a and 85.b) and the overall impacts on flooding have been reduced when compared with the impacts assessed under the EES.

Furthermore, the assessment of site runoff has shown that four turbine locations would be subject to inundation along some of the flow paths activated during intense rainfall. Modelling results indicate water depths above 100 mm for the 1% AEP event are to be expected in those four locations. These impacts are less than the impacts assessed under the EES and can be managed through detailed design and in the Construction Environmental Management Plan as envisaged by the Permit conditions.

Waterway crossings require a Works on Waterway Permit from CMA. The Permit will require crossings are designed adequately for any infrastructure that intersects a waterway (i.e. fords/culverts that do not impede flow), hence the proposed wind farm will not alter the hydrology of the waterways (permit condition 85.c). Appropriate treatment of surface water runoff carrying increased sediment load during the construction phase will be required and can be appropriately managed through the Construction Environmental Management Plan.

It has been brought to our attention that the Project is seeking approval to use a larger turbine rotor than initially proposed; however, we understand the size of foundations and hardstands won't change, hence this will not modify flood behaviour on site and the outcomes of this assessment.

It is Water Technology's opinion that the overall flood risk of the site has not changed significantly, and in many cases has been improved. We do not believe that the revised layout will have any adverse impacts beyond that of the original layout considered in the Environment Effects Statement.