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Turoa Road Flood Mitigation Options

For Whanganui District Council

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Executive Summary

There has been recent flooding along Turoa Road and Ikitara Road in June 2015, November 2020, December 2021 and May 2023. The extent of the flooding varied between storm events due to different storm intensities. The 2015 flood was the largest with 32 properties and 18 ancillary buildings flooded however, no houses were flooded. The more recent three storm events had low return periods between 1-5 years and flooded approximately between 10-20 properties and 2-5 ancillary buildings. Prior to the 2015 flood low return period storms did not cause properties to flood along Turoa Road indicating something has changed within either the catchment, drain or weather that is causing frequent floods to occur

Whanganui District Council are partnering with Horizons Regional Council to commission a flood mitigation report for the purpose of assessing all options that may mitigate flooding along Turoa Road and Ikitara Road properties. As part of this report the community has been consulted twice to discuss the initial findings of this assessment and for their ideas to mitigate inundation.

The purpose of this report is to determine whether each option will work, the Level of Service for each option (described as a return period) and provide a construction estimate. The following table summarises the findings and construction estimates.

Option	Level of Service	Estimated Cost
1. Stabilise landslide that blocks the drain adjacent 9 Turoa Road		$200k - $250k
2. Clear the drain twice annually	1 in 5 year storm event	$2k - $4k / year
3. Partially extend pipe to 15 Turoa Road	1 in 1 year storm event	$150k-$210k
4. Construct two detention dams upstream of Turoa Road	1 in 100 year storm event	$1.1-$1.3 million
5. Widen drain and install larger culverts under Ikitara Road and Raine Street	1 in 100 year storm event	1.4-1.8 million
6. Install overflow box culverts along Turoa Road	1 in 100 year storm event	$4.3-5.6 million
7. Extend stormwater pipe up Turoa Road Drain	1 in 5 year storm event	$870k–1.1 million
8. Build a stopbank between houses and drains.	Likely to fail, not a suitable option.	
9. Lift garages to prevent flooding	No change in Level of Service	$100k - $300k

Refer to Figures 1-6 for a concept plan for most options and the extent of work.

Geocivil Consulting Engineers recommend in the short term Option 1 (stabilise landslide) is constructed to prevent inundation and Option 4 (detention ponds) long term.

The current system of drain maintenance along Turoa Road is not providing a functional drain. With an active landslide adjacent 9 Turoa Road and vegetation clogging the drain I recommend council take over responsibility to maintain the drain up to the eastern end of Turoa Road. The cost of maintenance should be carried by either one council or both with one council contributing to the other council that clears the drain.

1. Table of Contents

2. Introduction

The Turoa Road Drain conveys stormwater (SW) from farm land east of Turoa Road along the northern side of Turoa Road through residential property between Ikitara Road and Raine Street and into the Matarawa Stream. The properties along the northern side of Turoa Road and between Ikitara Road and Raine Street have within the last ten years started to become more frequently inundated. The residents have approached Whanganui District Council to help address the frequently occurring inundation on their properties.

In this report the Turoa Road Drain begins at the eastern end of Turoa Road (37 Turoa Road) and finishes at Matarawa Stream (11 Raine Street).

Whanganui District Council and Horizons Regional Council are partnering to commission a specific study on high level options to mitigate the inundation experienced by residents at Turoa Road.

The scope of this flood assessment is to review historic flooding along the Turoa Road Drain, carry out a walkover of the drain and catchment, produce a hydraulic analysis of the existing stormwater system and provide remedial options to mitigate flooding. The stormwater capacity of each option will be determined, an estimated cost and the advantages and disadvantages to build. Community consultation has been undertaken twice with residents to listen and take on board their ideas to mitigate the inundation. These options will be presented to both councils and residents of Turoa Road in a public meeting.

The purpose of this report is to present the feasibility of each option, the level of service for each option, described as a return period and provide a construction estimate.

3. Historic Flooding in Turoa Road Drain

Within the last ten years there have been four recorded flood events along the Turoa Road Drain, these were on 19-21 June 2015, 25 November 2020, 15 December 2021 and 20 May 2023. The 2015 flood was the largest flood event having a return period of 1 in 130 years and inundated all the properties along the northern side of Turoa Road and properties between Ikitara Road, Raine Street and the Turoa Road Drain. Refer to Figure 7 for the 2015 flood extent.

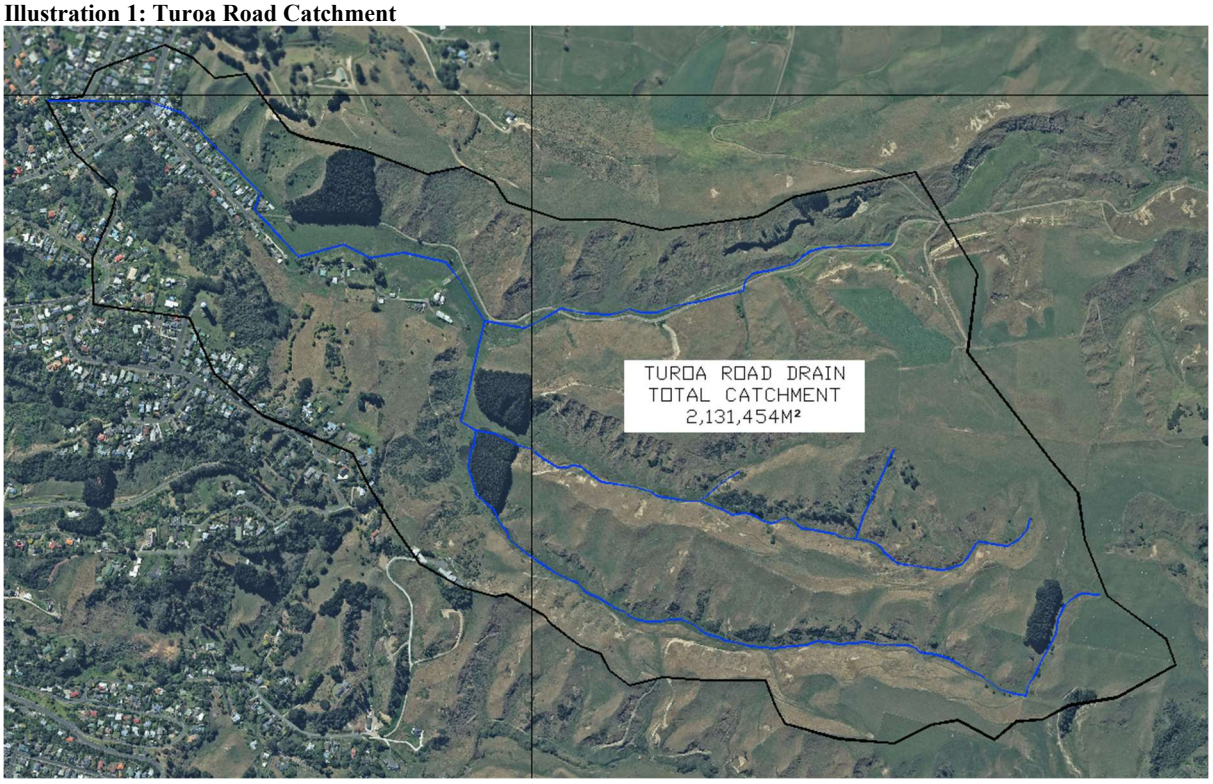
Subsequently there were three smaller flood events, these floods were caused by storms that had very low return periods, between 1-5 years. The extent of the flooding was not as extensive as the 2015 flood but typically confined to backyards and through garages and under some homes. There were between 10-20 properties flooded during these three storm events and 2-5 garages. Refer to Figures 8-10 for an approximate extent of flooding of each storm.

Prior to the last ten years storms with a low return period did not cause properties to flood along Turoa Road indicating something has changed within either the catchment, drain or weather that is causing frequent floods to occur.

4. Turoa Road Drain Catchment

The Turoa Road Drain catchment covers an area of 2.1 km², the central and eastern side of the catchment is predominantly farm land. The western side of the catchment is predominantly urban and includes a small urban area of Bastia Hill bounded by Mount View Road and Bastia Avenue, Turoa Road and the southern end of Raine Street. Refer to Illustration 1 for the Turoa Road catchment.

Illustration 1: Turoa Road Catchment



4.1 Historic Drain Development

A review of the historic aerial photographs taken of the Turoa Road area show a manmade drain was excavated through the existing houses on the northern side of Turoa Road. Anecdotal evidence indicates the stream was realigned in the 1960's, probably for the purpose of constructing the houses presently along the northern side of Turoa Road.

Illustration 2: 1946 and 2024 Turoa Drain Alignment

4.2 Existing Drainage System

The existing drainage system is a combination of concrete culverts and open drains. The drain, for the purpose to describe, is divided into three sections, the urban drain, Turoa Road and farm land.

The urban section of the Turoa Road Drain begins at the confluence of the Turoa Drain and Matarawa Stream (11 Raine Street), the system consists of a 3.5 m deep straight drain that is piped under Raine Street through a 1200mm diameter culvert. The drain between Raine Street and Ikitara Road reduces in depth to 1.3m and has a number of constrictions caused by built retaining walls and planted trees along the side and in the drain. The drain continues under Ikitara Road through a 1050mm pipe that enlarges to a 1350mm pipe.

Along Turoa Road the drain traverses the boundary of a farm and urban land. The drain is clogged with vegetation in sections. There are also two retaining walls constricting the stream adjacent 9 Turoa Road. Beside these retaining walls is an active landslide. Anecdotal information indicates the landslide moves regularly and has moved during each of the four storm vents discussed in this report to either close or constrict the Turoa

Road Drain. The drain continues upstream and flows through 37 Turoa Road property and then enters farm land. The section of drain within 37 Turoa Road is heavily overgrown with vegetation.

The drain within the farm land now reduces in depth to 0.5 m. Approximately 500 m upstream from entering this farm land is an existing detention dam approximately 3 m high. The dams primary outflow is a 600 mm diameter pipe with headwalls and secondary outflow is a concrete spillway, both outflows are functional. Anecdotal evidence indicates the regional council at the time built the dam to reduce the risk of flooding along Turoa Road, Ikitara Road and Raine Street. The drain upstream further divides into three gullies that leads into the top of the Turoa Road Drain catchment as shown in Illustration 1.

5. Hydrology and Hydraulic Analysis

A hydrology analysis has been completed using the Rational Method to estimate the peak flow from a storm event with an annual probability of exceedance of 50%, 20%, 10%, 5% 2%, 1% and 0.5%. This annual probability will be presented as a return period within this report because the report will be public and the concept of a return period is generally better understood by the public.

The catchment is made up of 6% urban and 94% rural land. The urban land has typically an impervious area between 36%-50% and rural land type divided between pasture and forest. Refer to Table 1 for a breakdown of the land types.

Table 1: Catchment Land Types

Land Type	Coverage	Area
Rural	Forest (1.8%)	38,700 m²
	Pasture (91.8%)	1,956,754 m²
Urban	Urban property (5.9%)	126,500 m²
	Road (0.5%)	9,500 m²
Total Area		2,131,454 m²

The rainfall depth for each return period is based on a representative concentration pathway 6.0 scenario that takes into account the potential for an increase in rainfall due to global warming. Estimated peak flows from the hydrology analysis are shown in Table 2.

Table 2: Peak Flows

Return Period	2 years	5 years	10 years	20 years	50 years	100 years	200 years
Peak Flow (m³/sec)	2.2	3.9	5.1	6.5	8.3	9.7	12.3

A number of methods in the hydraulic analysis have been used depending on the remedial option assessed and section along Turoa Road Drain. Manning's equation has been used for open channel flow, the Colebrook-White Formula for the piped stormwater systems,

nomographs for short culverts and the software Hydrocad for modelling detention ponds using a Storage Indication Translation Method.

5.1 Stormwater System Capacity

Stormwater systems within Whanganui City when designed are required to have two flow paths in the event one path blocks, a primary system and a secondary system. The primary system is designed to pass a 1 in 10 year storm event and is typically a piped SW system, the secondary system is designed to pass a 1 in 100 year storm event and also acts as an overland flow path such as a drain, road or public parks. In the event there is only one SW system, the system capacity should be designed to convey a 1 in 100 year storm event.

The Turoa Road Drain has been built progressively since the late 19th century and therefore does meet the current national standards. Refer to Figure 11 that shows the capacity of sections of Turoa Road Drain that can pass a flow for a given return period.

5.2 Historic Flood Events

Table 3 summarises the recent flood events since 2015, properties and ancillary buildings flooded.

Table 3: Historic Flood Events

Flood Date	Storm Event Return Period (RP)	Properties Flooded	Ancillary Buildings Flooded
21 June 2015	130 year return period	32	18
25 November 2020	2-5 year return period	11	2
15 December 2021	Less than a 1 year return period	10	2
20 May 2023	5 year return period	22	5

The approximate extent of these floods is shown on Figure 7 - 10. The flood extent is based on anecdotal evidence, historic photographs of the flood events, the contour plans of Turoa Road drain and historic newspaper articles.

No houses were inundated during all four flood events, only ancillary buildings. An ancillary building is considered a structure that is an accessory to a home and not intended for human habitation, i.e. a garage or implement shed.

The 2020, 2021 and 2023 storm events would typically be expected to be contained within a modern stormwater system. Anecdotal evidence indicates frequent flooding did not occur along Turoa Road prior to 2015, which indicates the system has reduced in capacity since the 2015 flood event. The landslide adjacent 9 Turoa Road appears to have moved prior to these storm events, causing either a construction or blockage in the drain. Figure 8, 9 and 10 show flooding upstream of this landslide indicating that the landslide may have been the primary cause of the 2020, 2021 and 2023 floods.

5.3 Stormwater System Constrictions

There are a number of constrictions observed along the stormwater system, the capacity of these constrictions have been assessed against the return period they are likely to pass and are shown in Table 4. Historic rainfall data has been used to determine the return period capacity because the pass performance of the SW system should be compared with historic rainfall data. The purpose of assessing the capacity of the constrictions was to determine which one had the greatest detrimental effect on Turoa Road Drain. These are shown in order of greatest detrimental effect.

Table 4: Stormwater System Constrictions

Constriction	Return Period (RP) Capacity
1. Slow moving landslide beside drain adjacent 9 Turoa Road	Zero capacity. Landslide blocks drain.
2. Overgrown weeds in Turoa Road Drain	Less than a 1 year RP
3. Retaining wall in Turoa Road Drain adjacent 9 Turoa Road	Less than a 1 year RP
4. Stormwater pipe under Ikitara Road	Less than a 1 year RP
5. Constrictions in drain between Ikitara Road and Raine Street	1 in 2 year RP
6. Raine Street culvert	1 in 10 year RP

The constriction with the greatest effect is the slow moving landslide that tends to either constrict or eventually block the stream. The flood extent for the 2020 and 2021 flood show flooding at the location of the landslide indicating the most likely cause of these flood events was this landslide. Anecdotal evidence confirms the landslide has moved during all four flood events which coincides with frequent flood events.

6. Flood Mitigation Options

The following tables provide the assessed short term and long term flood mitigation options, their scope of work to construct, the SW system capacity and an estimate to construct. All estimates exclude GST. No cost for land purchase, consent process or consultation has been incorporated into the estimated cost. There is a 30% contingency applied to the estimated cost.

Table 5: Short Term Solutions

Option	Scope of Work	System Capacity	Advantages	Disadvantages	Estimate Costs (Excl GST)	Assumptions
1.Stabilise landslide adjacent 9 Turoa Road	• Construct two retaining walls to stabilise slip • Form access track through slip	1 in 1 year storm event.	• Landslide cannot block drain as in previous flood events. • Retaining wall through landslide provides access track for future maintenance.	• Ongoing maintenance of retaining wall.	$200,000 – $250,000	Access is over 21 Turoa Road
2. Clean drain out on 21 and 37 Turoa Road	• Clear drain twice annually	1 in 1 year storm event.	• Cleared drain		Initial clearance $10,000 – 15,000 Ongoing annual cost $4000 – $6000	Can access private property

Table 6: Long Term Solutions

Option	Scope of Work	System Capacity	Advantages	Disadvantages	Estimate Costs (Excl GST)	Assumptions
3.Widen Turoa Road Drain and increase culverts size	• Widen drain to 3m width along Turoa Road. • Remove existing 1350mm pipe. • Excavate drain through the back yards of 3, 5 & 7 Turoa Road. • Remove house at 1A Turoa Road • Remove half of the building on 106 Ikitara Road • Widen drain to 3 m width between Ikitara Road and Raine Street. • Build box culverts under Ikitara Road and Raine Street.	1 in 100 year storm event.	Can meet a modern SW standard.	• Need to take approx. 3m wide strip of 3, 5, 7 Turoa Road backyard. • Move house off 1A Turoa Road. • Remove half of the commercial building on 106 Ikitara Road. • Ongoing maintenance required to drain.	$1.4 – $1.8 million	Dump site is within 5 km.
4. Extend SW pipe up Turoa Road Drain	Extend the existing 1350mm pipe up the drain into Gudsell Farm and construct a small dam.	1 in 5 year storm event.		• The drain has been filled in, any storm over a 1 in 5 year return period will flow through Turoa Road properties.	$870,000 – $1,100,000	Borrow site is within 5 km.
5. Partially extend pipe to 15 Turoa Road.	Lay a 1350mm pipe to the back of 15 Turoa Road.	1 in 1 year storm event.	The farmer can more easily maintain the remaining drain on his farm.	• Stormwater system capacity approximately has a 1 in 1 year return period. • Ongoing maintenance required to drain. • Issue maintaining drain on 37 Turoa Road.	$150,000 – $210,000	No retaining wall needed to lay 1350mm dia. pipe.

Table 7: Long Term Solutions (continued)

Option	Scope of Work	System Capacity	Advantages	• Disadvantages	Estimate Costs (Excl GST)	Assumptions
6. Build 0.6m high stopbank between houses and Turoa Road Drain	Construct a small earth bund beside drain.	1 in 2 year storm event.		• Likely to fail in a storm event exceeding a 1 in 2 year return period. • Water will tend to pond behind stopbank on properties. • High probability of failure from house stormwater downpipes allowing flood water into properties. • Ongoing maintenance required to drain.	Not priced.	
7. Construct a detention dam at the end of Turoa Road on farm land	Construct a new 2 m high earth dam across Turoa Road gully and existing dam is undercut and upgraded.	1 in 100 year storm event.	Can hold up to a 1 in 100 year storm event. Will reduce the peak flow into the Matarawa Stream by 70%.	• Need to purchase farm land or obtain rights to use land for stormwater detention. • Need to rebuild existing dam. • In the event the dams primary system is blocked or is overtopped in a 1 in 100 year RP storm, the primary flow path and spillway's peak flow is 1.2m³/sec. This flow of water should be contained with a maintained drain. • Ongoing maintenance required to drain.	$1.1 – $1.3 million	Borrow site is within 5 km of dam. Property purchase is estimated at $400k.
8. A large overflow box culvert along Turoa Road.	Construct new two sewer lines along Turoa Road and reconnect houses on both sides of street. Realign 40m of water supply line. Install two box culverts (1 m high x 2 m wide).	1 in 100 year storm event.	Can meet a modern SW standard.	• Silt will build up along the length of the box culverts. This will become an expensive maintenance cost. • Traffic disruption on Turoa Road for approximately one year. • Relay sewer line along both sides of box culvert. • Ongoing maintenance required to drain.	$4.3 - $5.6 million	
9. Lift garages to prevent flooding	Lift garages adjacent the Turoa Road Drain that have been flooded in the past.	No change		• Properties continue to be flooded.	$100k - $300k	No Specific Engineering Desing is required to lift garages.

The following table provides the flood mitigation options in order of least cost to invest for the largest benefit gained. The benefits are considered the largest reduction in properties flooded and the SW capacity within the section of the drain being improved.

Table 8: Order of Cost to Benefit

Option	Cost (excl GST)	Benefits		
		Estimated Reduction in Properties Flooded	SW Capacity Increase[1]	
			Existing	New
Stabilise landslide adjacent 9 Turoa Road	$200,000 – $250,000	10	1 in 1 year RP	1 in 100 year RP
Clean drain out on 21 & 37 Turoa Road	Initially $10,000 – $15,000 Ongoing $2000 – $4000	13	1 in 1 year RP	1 in 5 year RP
Partially extend pipe up to 15 Turoa Road	$150,000 – 210,000	10	1 in 1 year RP	1 in 5 year RP
Construct detention dams at the end of Turoa Road on farm land.	$1.1 – $1.3 million	26	1 in 1 year RP	1 in 1 year RP
Widen Turoa Road drain and increase culvert size	$1.4 – $1.8 million	17	1 in 1 year RP	1 in 100 year RP
Install large overflow box culvert along Turoa Road	$4.3 – $5.6 million	13	1 in 1 year RP	1 in 100 year RP
Extend SW pipe up Turoa Road drain	$870,000 – $1,100,000	0	1 in 1 year RP	1 in 5 year RP
Build 0.6m high stopbank along drain	Not priced	Nil	1 in 1 year RP	-
Lift garage buildings	$100k - $300k	Nil	1 in 1 year RP	1 in 1 year RP

[1] Only applies to the section of the drain being improved, not the entire length of the drain.

The above options are not all suitable to construct nor provide an adequate solution to the flooding problem but have been assessed to demonstrate a thorough flood assessment has taken place.

In the short term Option 1, to stabilise the landslide, is considered to have the greatest Level of Service on the drain by eliminating the risk of blockage. The second most effective option is a regular drain clearing program.

Option 7, constructing two detention dams, is the recommended options because it cost the least to achieve the minimum capacity for a modern stormwater system and causes the least affect to residents on Turoa Road.

Most of the above options still require the Turoa Road Drain to be constantly maintained to function properly and at the date of this report drain maintenance along Turoa Road, as I understand, is in part maintained by the property owners. This approach seems fundamentally flawed given the public rely on its maintenance to prevent inundation and maintenance will vary between property owners. An example of this is where the drain flows through two properties, the first property owner has access to equipment to satisfactorily clear the drain and the second property owner has neither the funds nor ability to clear the drain. The drain will not function taking this approach. I recommend either one or both councils contribute to clearing the drain given its effects on local residences. The regional council could pay part of the cost of maintenance while Whanganui District Council carries out the maintenance work. This approach will require an easement and the legal right to enter the property for the purpose of maintenance.

7. Conclusions

Geocivil Consulting Engineers conclude:

1. Currently Turoa Road Drain does not have enough capacity to pass a 1 in 1 year storm event.
2. There are six constrictions occurring along the drain, these are in order of most detrimental effect:
    a. A slow moving landslide adjacent 9 Turoa Road blocks the Turoa Road Drain.
    b. The drain is overgrown with weeds.
    c. Two retaining walls built in the drain beside 9 Turoa Road.
    d. The stormwater pipe under Ikitara Road.
    e. Constrictions along the drain between Ikitara Road and Raine Street.
    f. The 1200mm diameter culvert under Raine Street.
3. Option 4, to construct a small stopbank between Turoa Road Drain and houses along Turoa Road, has a high probability of failure and is not considered a feasible option to mitigate flooding.

8. Recommendations

Geocivil Consulting Engineers recommend:

1. A retaining wall is constructed to stabilise the landslide adjacent 9 Turoa Road.
2. Long term Council construct two new detention dams at the end of Turoa Road to reduce the stormwater flow along Turoa Road Drain.
3. The on-going maintenance of Turoa Road Drain should be maintained by Council and either shared between both local and regional council or by one. This public drain should not be maintained by individual property owners.
4. A legal easement is formed to allow access by council to maintain the drain over part of the farm on the northern side of Turoa Road Drain (21 Turoa Road).

9. Limitations

1. This report describes the site investigation, process, data collected and interpretation of data obtained from this work. Its conclusions are only valid for the purpose for which it was requested.
2. While every care has been taken in the compilation of this report, to the extent that its conclusions are based on the analysis of the data interpreted from on site conditions, no responsibility or liability is accepted for consequences arising from variations in the ground conditions.
3. If ground conditions vary during construction Geocivil Consulting Engineers should be contacted in order to review and if necessary amend the recommendations of this report.
4. No liability or responsibility is accepted by Geocivil Consulting Engineers by a third party that relies on information in this report or consequences of this document being used for purposes other than for which it was commissioned.
5. Local iwi and hapu have not been consulted about the work that has been carried out to complete this report as required under the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. An attempt has been made by Whanganui District Council however, a representative from local hapu were not able to established.

10.Figures

GEOCIVIL
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Option 1 - Construct Retaining Wall to Stabilise Slip
Scale 1:2500 (A4)

Figure 1
Project Number: 23-033

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Option 3 - Partially Extend Pipe to 15 Turoa Road
Scale 1:2500 (A4)

Figure 2
Project Number: 23-033

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Option 4 - Detention Dam End of Turoa Road
Scale 1:2500 (A4)

Figure 3
Project Number: 23-033

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Option 5 - Widen Drain and Increase Size of Culverts
Scale 1:2500 (A4)

Figure 4
Project Number: 23-033

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Option 6 - Construct a Large Overflow Pipe along Turoa Road
Scale 1:2500 (A4)

Figure 5
Project Number: 23-033

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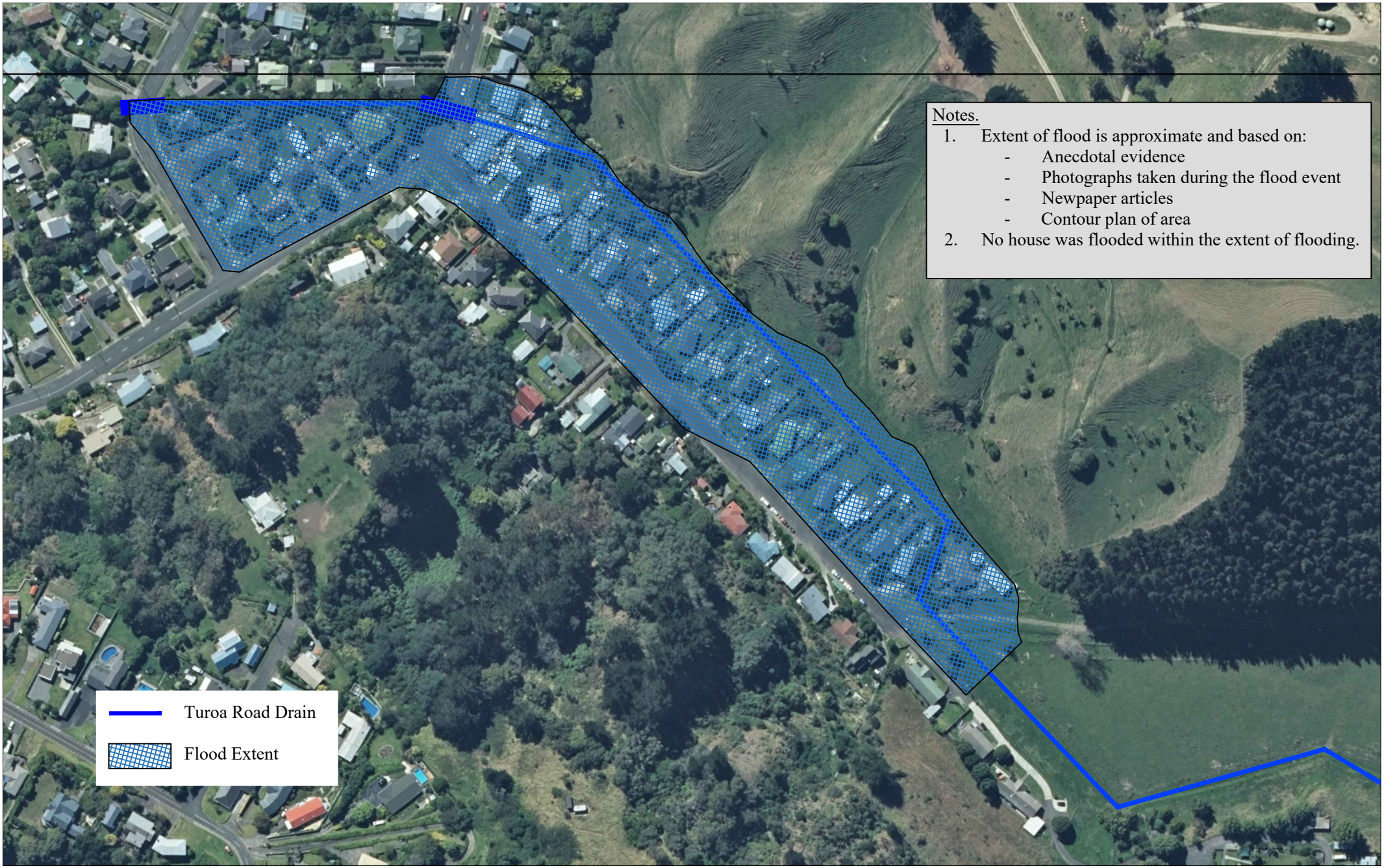
Option 7 - Extend Stormwater Pipe up Turoa Road Drain
Scale 1:2500 (A4)

Figure 6
Project Number: 23-033



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21 June 2015 - Flood Extent
Scale 1:2500 (A4)

Figure 7
Project Number: 23-033

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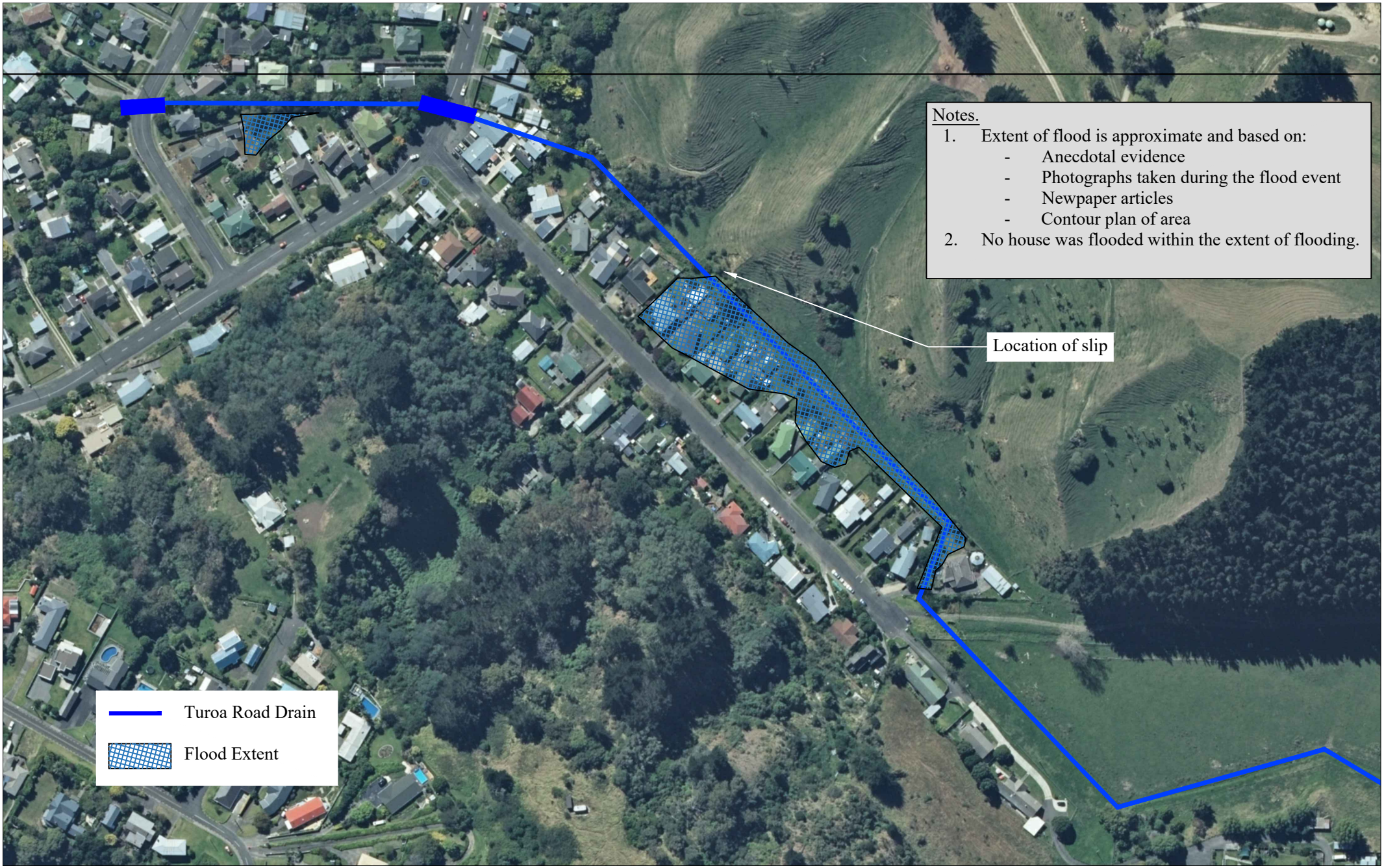
25 November 2020 - Flood Extent
Scale 1:2500 (A4)

Figure 8
Project Number: 23-033



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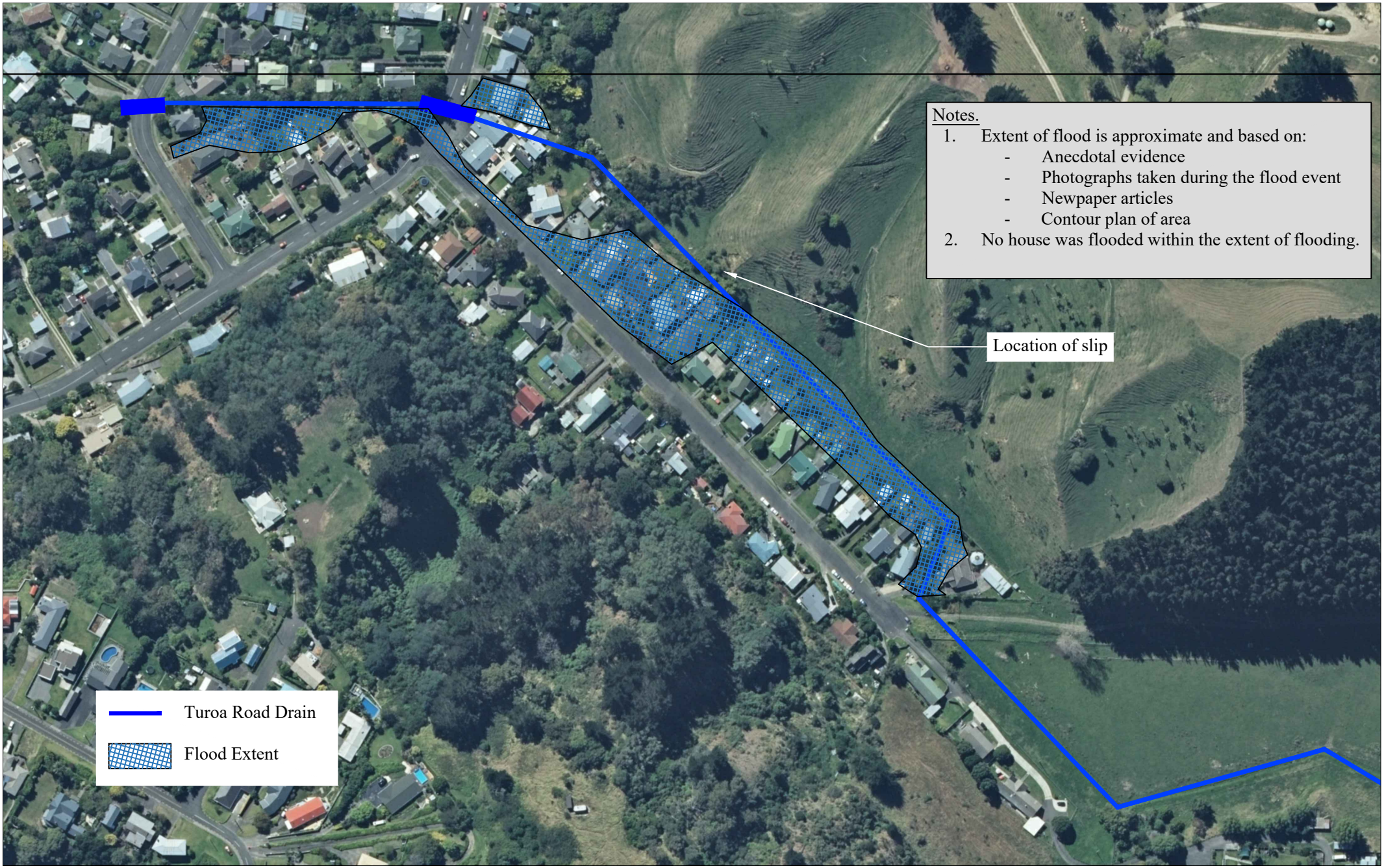
15 December 2021 - Flood Extent
Scale 1:2500 (A4)

Figure 9
Project Number: 23-033



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20 May 2023 - Flood Extent
Scale 1:2500 (A4)

Figure 10
Project Number: 23-033

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Turoa Road Drain Capacity
Scale 1:2500 (A4)

Figure 11
Project Number: 23-033