FIGURE 5
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
Z
AA
AB
AC
AD
AE
AF
AG

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 1 2 4 6 km

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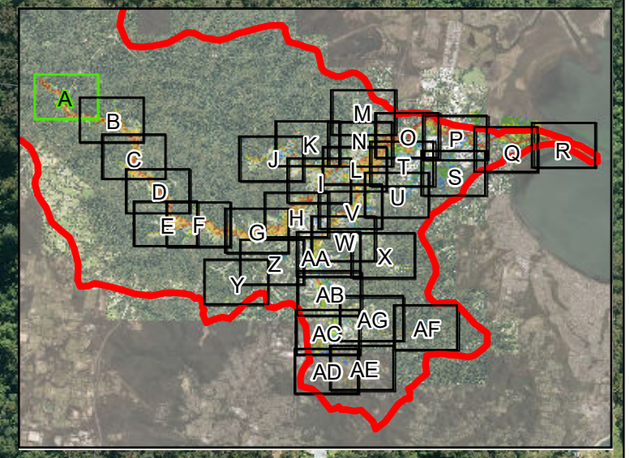
FIGURE 5A
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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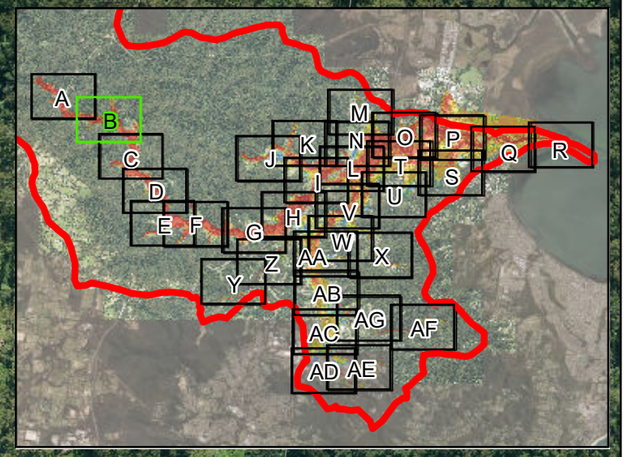
FIGURE 5B
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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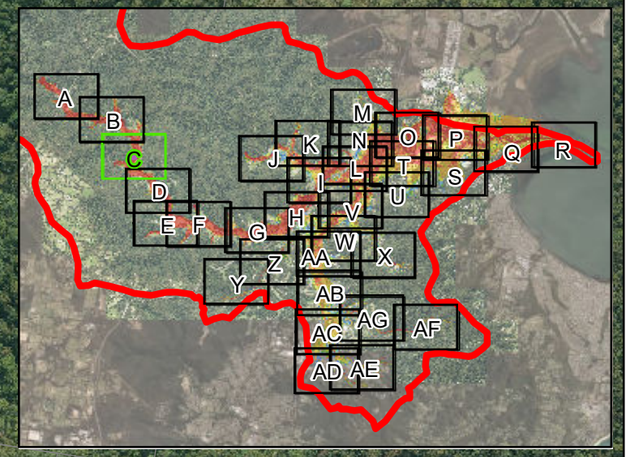
FIGURE 5C
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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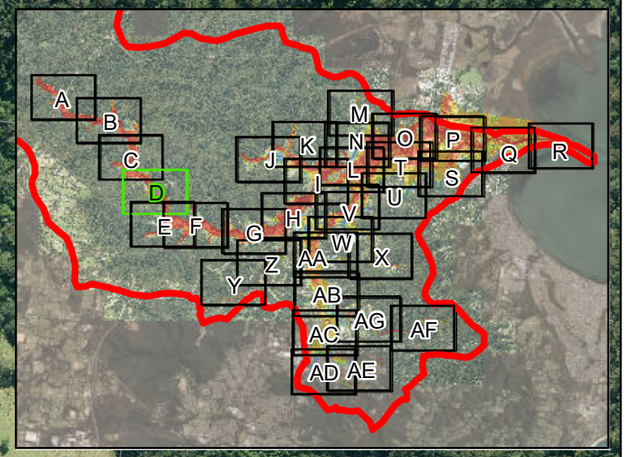
FIGURE 5D
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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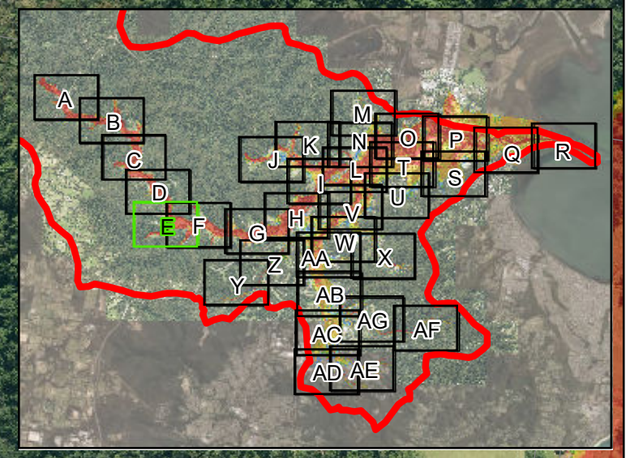
FIGURE 5E
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

Bumbles Ck

0 75 150 300 m @ 1:5000

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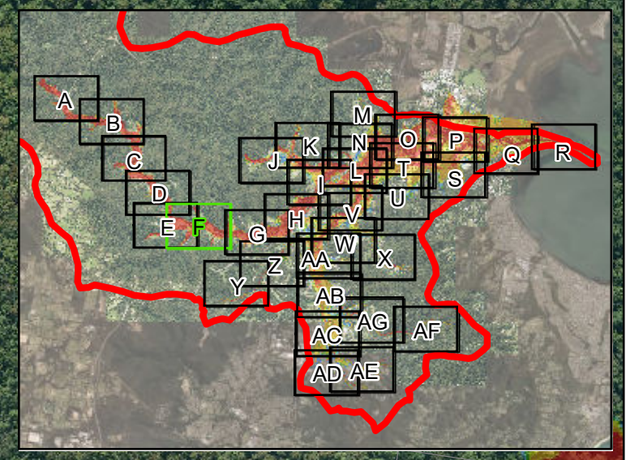
FIGURE 5F
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



Bumbles Ck

Ourimbah Ck

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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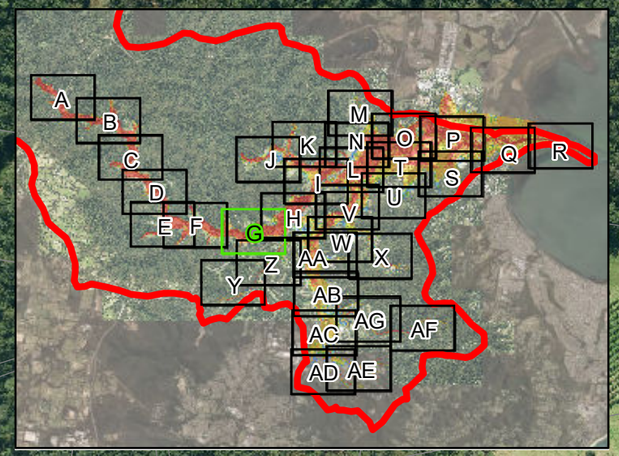
FIGURE 5G
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



Ourimbah Ck

SYDNEY NEWCASTLE FREEWAY

DOG TRAP ROAD

Dog Trap Gully

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

N

0 75 150 300 m @ 1:5000

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FIGURE 5H
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

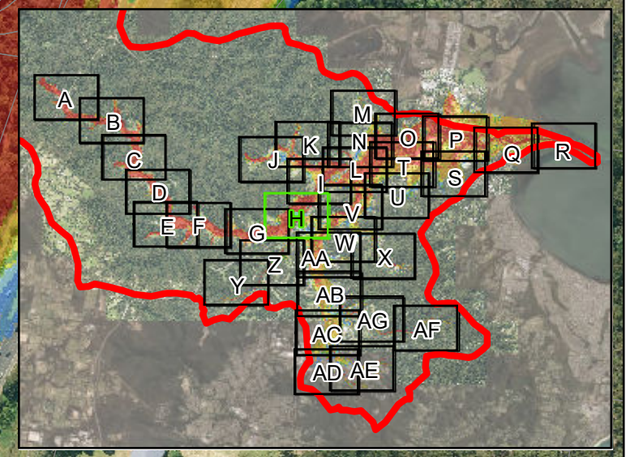
0 75 150 300 m @ 1:5000

N

Ourimbah Creek

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings



Ourimbah Ck

SYDNEY NEWCASTLE FREEWAY

PACIFIC MOTORWAY

PACIFIC HIGHWAY

YATES ROAD

BURNS ROAD

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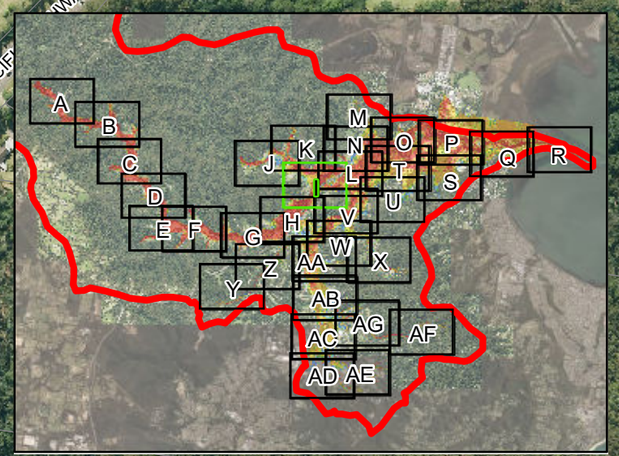
FIGURE 5I
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

Canada Drop Down Ck
PALMDALE ROAD
PALMDALE ROAD
FOOTTS ROAD
Ourimbah Ck
PACIFIC MOTORWAY
SYDNEY/NEWCASTLE FREEWAY
BRIDGE STREET



Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

N

0 75 150 300 m @ 1:5000

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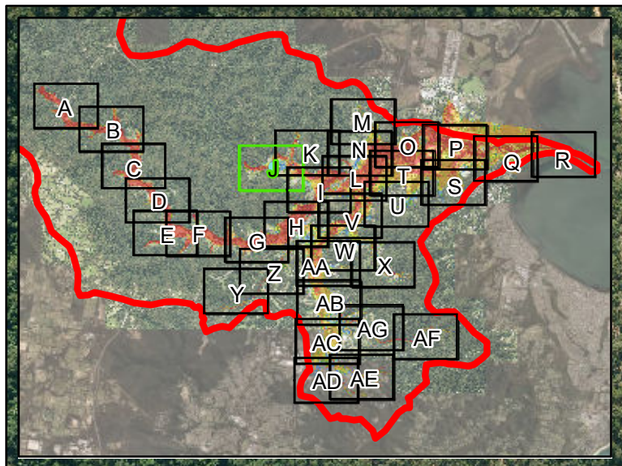
FIGURE 5J
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



Toohys Ck

Canada Drop Down Ck

FERN TREE LANE

PALMDALE ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 5K
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

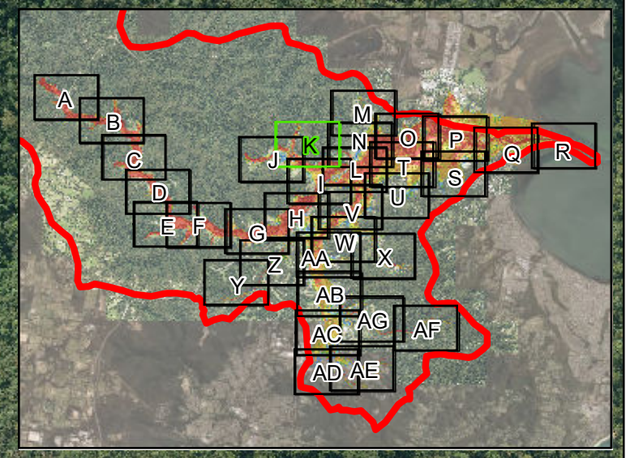
0 75 150 300 m @ 1:5000

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings



Toobys Ck

FERN TREE LANE

Canada Drop Down Ck

PALMDALE ROAD

Ourimbah Ck

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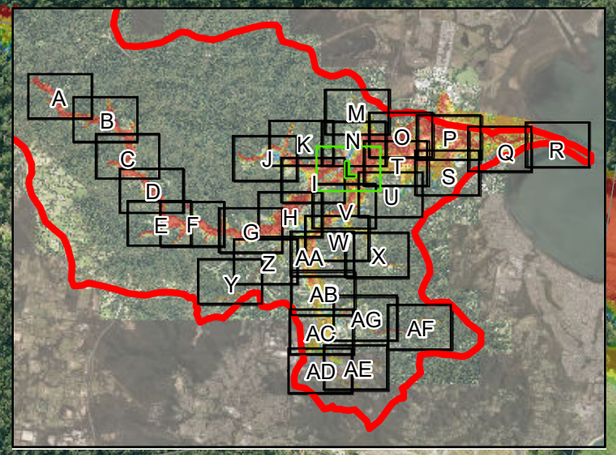
FIGURE 5L
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



Canada Drop Down Ck
Ourimbah Ck
ORCHARD ROAD
PALMDALE ROAD
SYDNEY NEWCASTLE FREEWAY
PACIFIC MOTORWAY
BRIDGE STREET
OURIMBAH ROAD
TURPENTINE ROA
NORTHERN RA
Chittaway Ck
PACIFIC HIGHWAY
N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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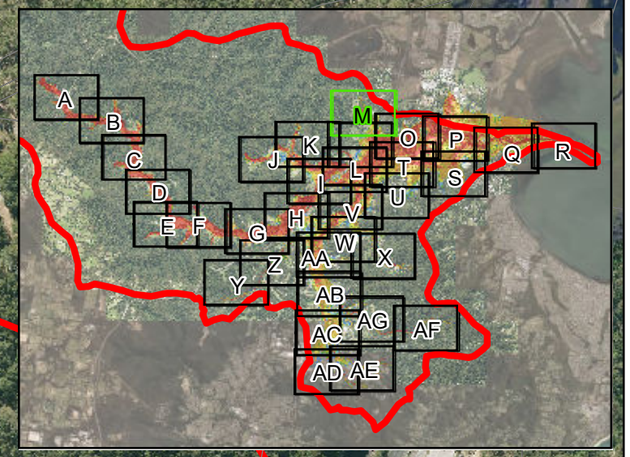
FIGURE 5M
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



SYDNEY NEWCASTLE FREEWAY

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 5N
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

0 75 150 300 m @ 1:5000

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AE AF AG

SYDNEY NEWCASTLE FREEWAY

Ourimbah Ck

ORCHARD ROAD

Canada Drop Down Ck

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FIGURE 5O
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

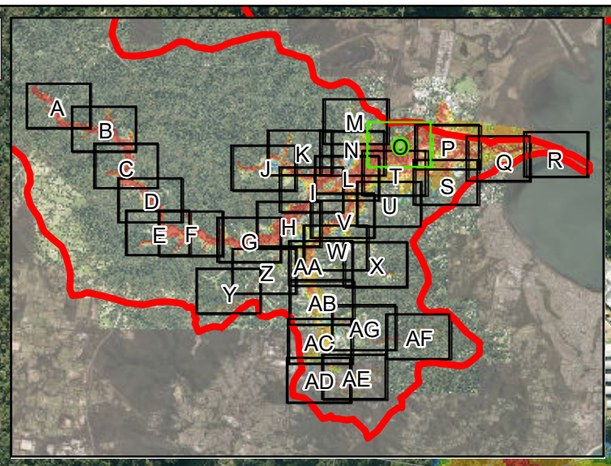
0 75 150 300 m @ 1:5000

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings



Ourimbah Ck

NORTHERN RAILWAY LINE

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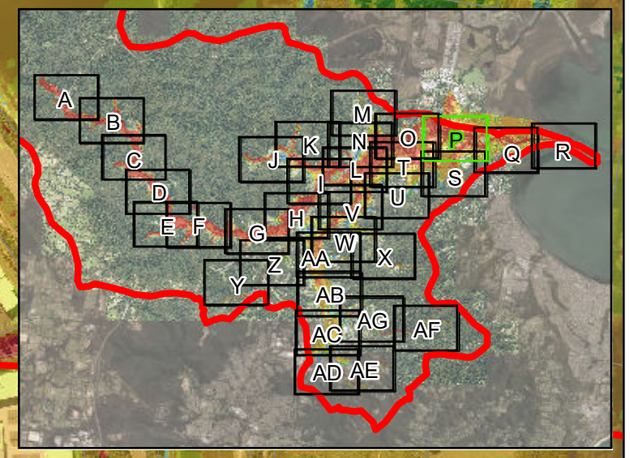
FIGURE 5P
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



RELIANCE DRIVE

NORTHERN RAILWAY LINE

Ourimbah Ck

HEREFORD STREET

CRAFTSMAN AVENUE

HEREFORD STREET

WYONG ROAD

APPRENTICE DRIVE

ENTERPRISE DRIVE

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 5Q
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

GEOFFREY ROAD
Ourimbah Ck
GEOFFREY ROAD
GEOFFREY ROAD
GEOFFREY ROAD
HYLES STREET
CHITTAWAY ROAD
KALUA DRIVE
CHITTAWAY ROAD
ALOHA DRIVE
WYONG ROAD

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AE AF AG

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

N

0 75 150 300 m @ 1:5000

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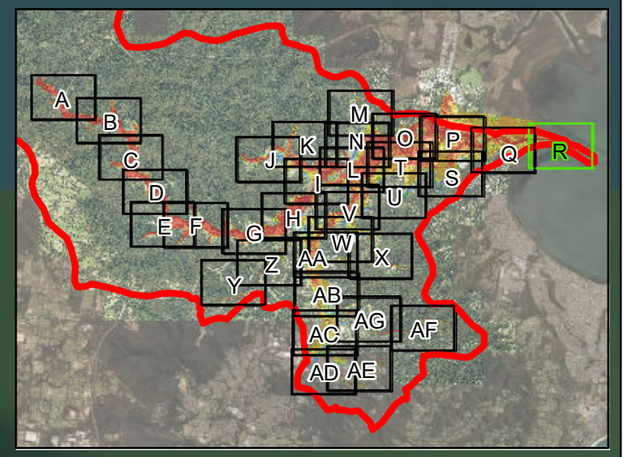
FIGURE 5R
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



HYLES STREET

GEOFFREY ROAD

KALUA DRIVE

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 5S
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

APPRENTICE DRIVE

ENTERPRISE DRIVE

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AE AF AG

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FIGURE 5T
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

Ourimbah Ck
Ourimbah Ck
ORCHARD ROAD
CHITTAWAY ROAD
OURIMBAH ROAD
TURPENTINE ROAD
ENTERPRISE
NORTHERN RAILWAY LINE
OLD CHITTAWAY ROAD
MANNS ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z AA AB AC AD AE AF AG

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FIGURE 5U
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

TURPENTINE ROAD
ENTERPRISE DRIVE
STATION ROAD E
NORTHERN RAILWAY LINE
OLD CHITTAWAY ROAD
MANNS ROAD
Chittaway Ck
OLD CHITTAWAY ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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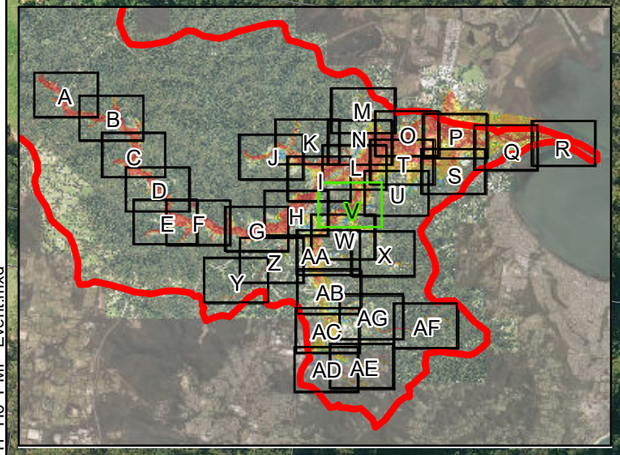
FIGURE 5V
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



PACIFIC HIGHWAY
OLD CHITTAWAY ROAD
Chittaway Ck
ENTERPRISE DRIVE
HOWES ROAD
BURNS ROAD
CHITTAWAY ROAD
PEACH ORCHARD ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 5W
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

BURNS ROAD
HOWES ROAD
CHITTAWAY ROAD
PEACH ORCHARD ROAD
CHITTAWAY ROAD
Dog Trap Gully
Chittaway Ck

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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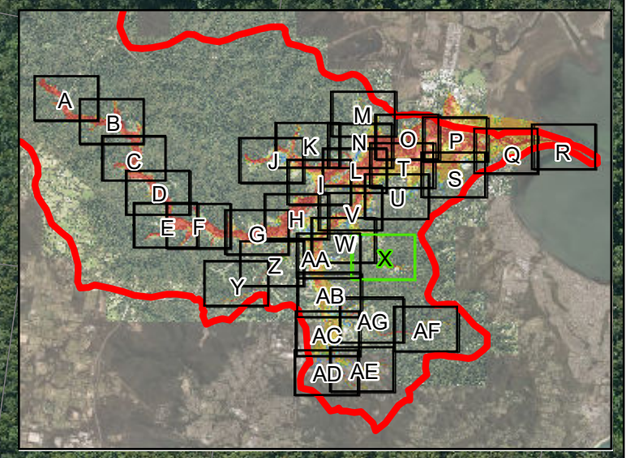
FIGURE 5X
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



Chittaway Ck

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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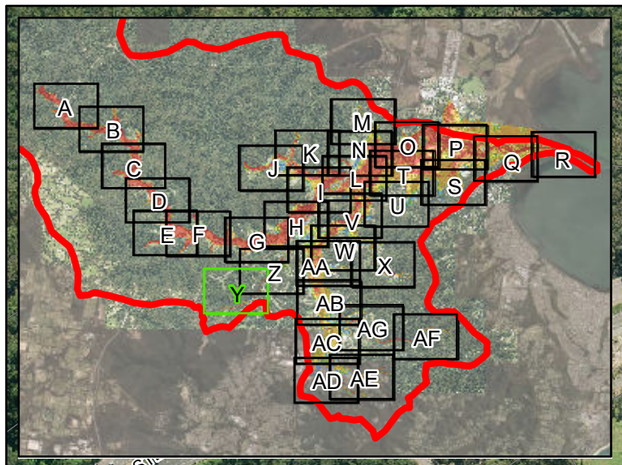
FIGURE 5Y
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



SYDNEY NEWCAS...

Dog Trap Gully

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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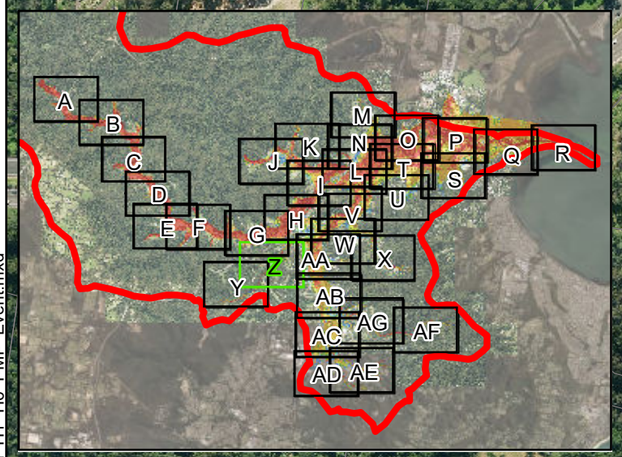
FIGURE 5Z
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

SYDNEY NEWCASTLE FREEWAY

DOG TRAP ROAD

Dog Trap Gully

Text



N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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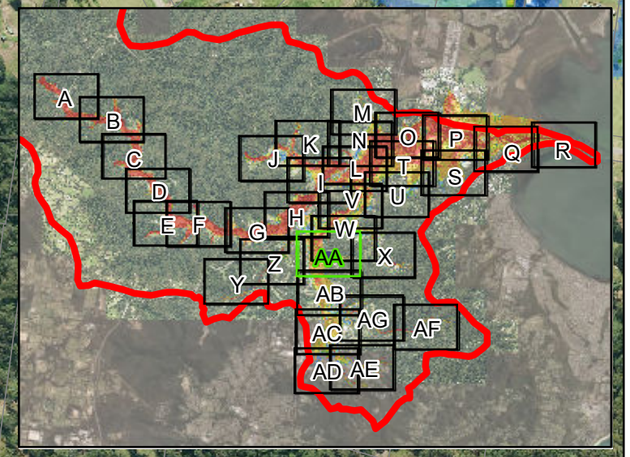
FIGURE 5AA
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



PACIFIC HIGHWAY
NORTHERN RAILWAY LINE
Dog Trap Gully
CHINTAWAY ROAD
CHARLES STREET
SHIRLEY STREET
THE BOULEVARDE
KING STREET
GLEN ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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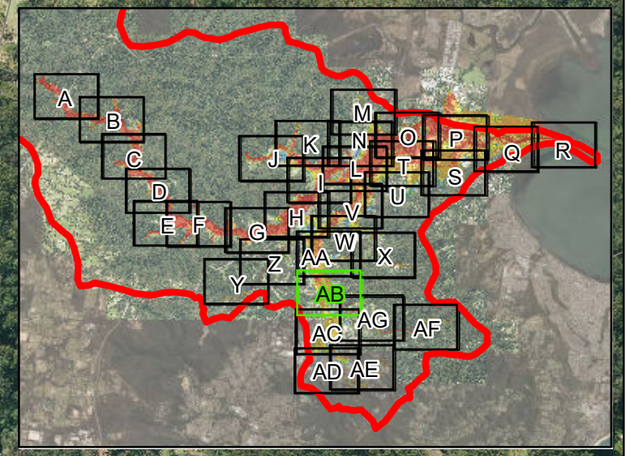
FIGURE 5AB
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



GLEN ROAD
SHIRLEY STREET
WALMSLEY ROAD
FINLAY CRESCENT
ROBERT HOLL DRIVE
PACIFIC HIGHWAY
NORTHERN RAILWAY LINE
Bangalow Ck
Cutrock Ck
LISAROW STREET
BAILEYS ROAD
PRYOR ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

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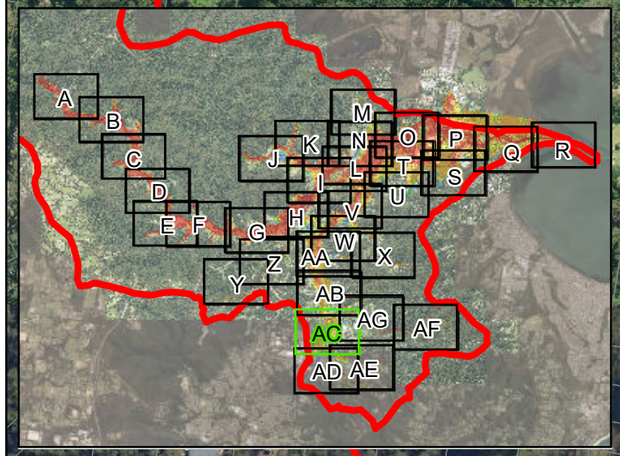
FIGURE 5AC
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



OURIMBAH STREET
PACIFIC HIGHWAY
TUGGERAH STREET
CUTROCK ROAD
PRYOR ROAD
CUTROCK ROAD
NORTHERN RAILWAY LINE
FAGANS ROAD
Cutrock Ck
MACDONALDS ROAD
O'DONNELL CRESCENT

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 5AD
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT

THE RIDGEWAY
THE RIDGEWAY
MACDONALDS ROAD
Cutrock Ck
TAPLEY ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

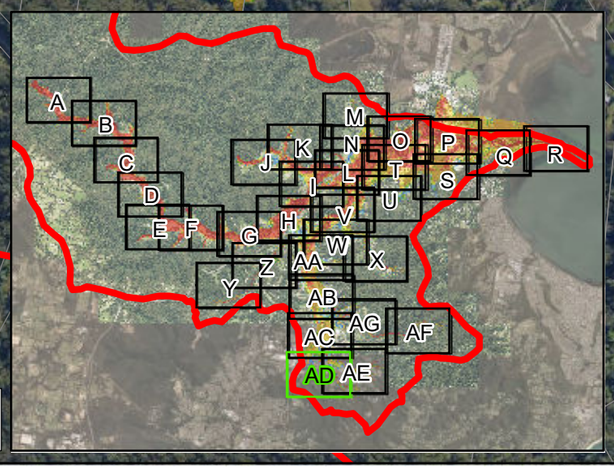

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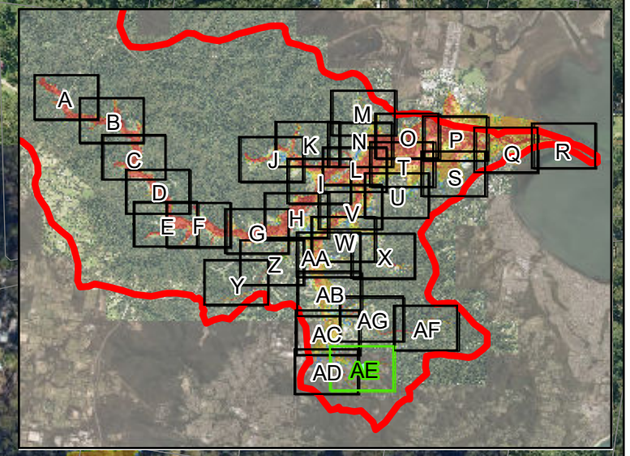
FIGURE 5AE
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



FAGANS ROAD
Cutrock Ck
THE RIDGEWAY
MACDONALDS ROAD
MACDONALDS ROAD
THE RIDGEWAY

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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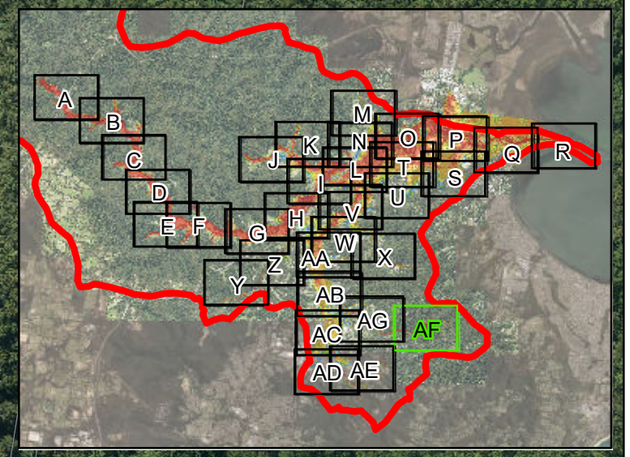
FIGURE 5AF
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



Bangalow Ck

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

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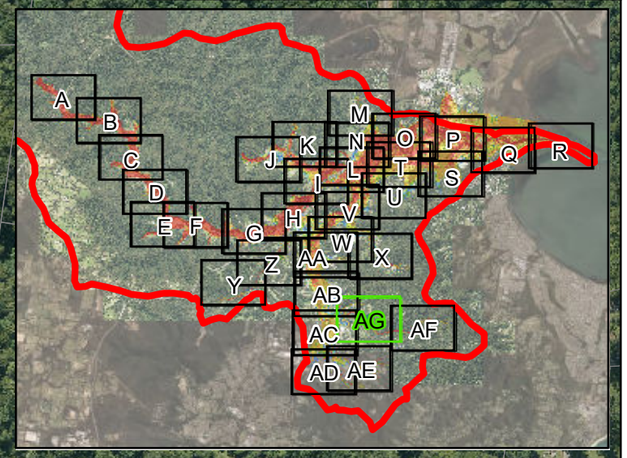
FIGURE 5AG
HYDRAULIC HAZARD CLASSIFICATION
PMF EVENT



PRYOR ROAD

Bangalow Ck

CUTROCK ROAD

N

Ourimbah Creek Catchment

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for small vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for people or vehicles. Buildings require special engineering design and construction
- H6 - Not suitable for people, vehicles or buildings

0 75 150 300 m @ 1:5000

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FIGURE 6

FLOOD EMERGENCY RESPONSE PLANNING CLASSIFICATIONS
5% AEP

SYDNEY NEWCASTLE FREEWAY
Ourimbah Ck
Drop Down Ck
Toobys Ck
Bumbles Ck
Dog Trap Gul
Chittaway Ck
Bangalow Ck
Cutrock Ck

N

Ourimbah Creek Catchment

FERP Classification

- Area with Overland Escape Route
- High Flood Island
- High Trapped Perimeter Area
- Indirectly Affected
- Low Flood Island
- Low Trapped Perimeter Area
- Overland Refuge Area on High Flood Island or High Trapped Perimeter Area
- Rising Road Access

0 1 2 4 km

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FIGURE 7

FLOOD EMERGENCY RESPONSE PLANNING CLASSIFICATIONS
1% AEP

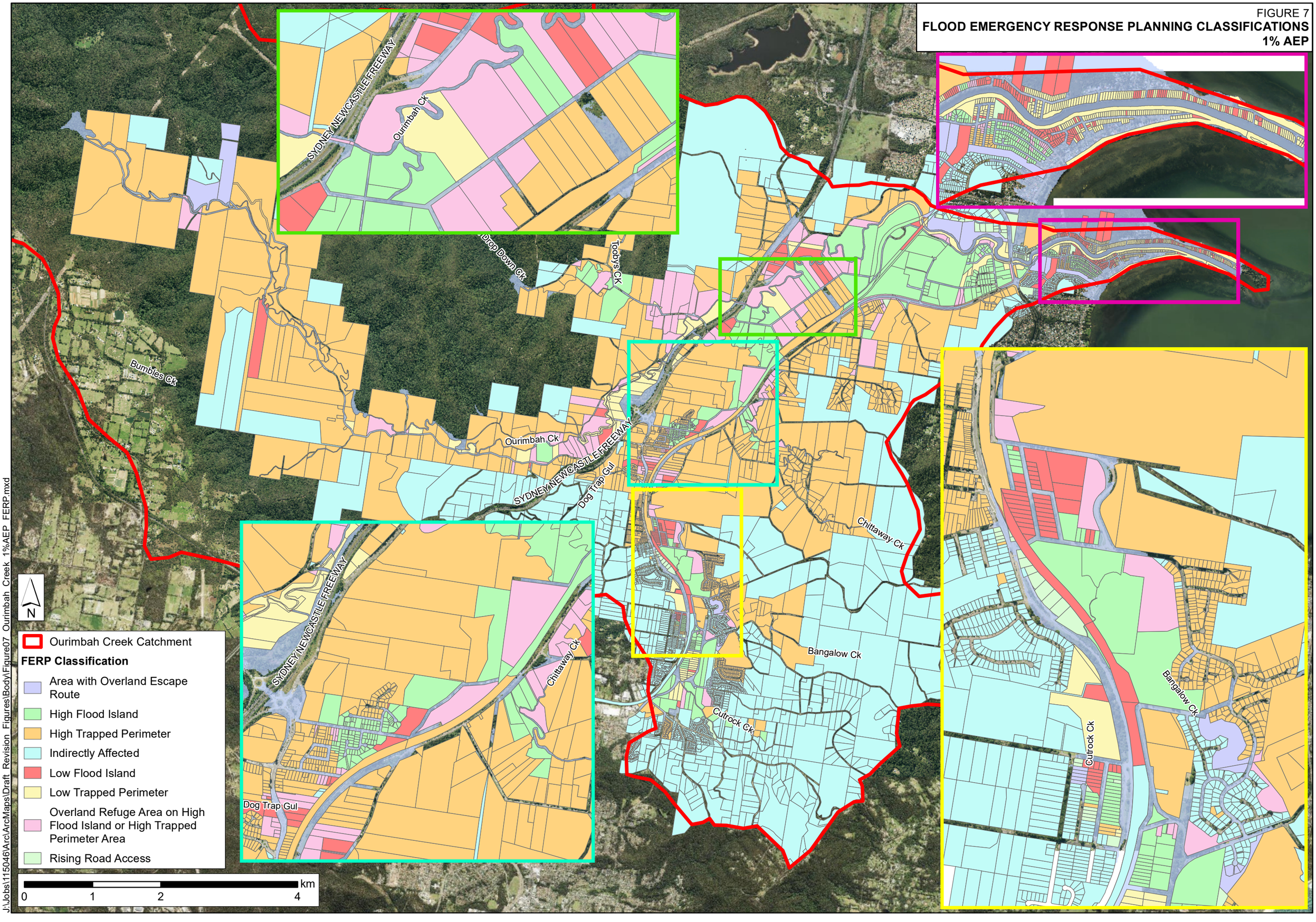

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FIGURE 8

FLOOD EMERGENCY RESPONSE PLANNING CLASSIFICATIONS
PMF

SYDNEY NEWCASTLE FREEWAY
Ourimbah Ck
Drop Down Ck
Toobys Ck
Bumbles Ck
Dog Trap Gul
Chittaway Ck
Bangalow Ck
Cutrock Ck

N

Ourimbah Creek Catchment

FERP Classification

- Area with Overland Escape Route
- High Flood Island
- High Trapped Perimeter Area
- Indirectly Affected
- Low Flood Island
- Low Trapped Perimeter Area
- Overland Refuge Area on High Flood Island or High Trapped Perimeter Area
- Rising Road Access

0 1 2 4 km

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FIGURE 9
RECOMMENDED MANAGEMENT MEASURES IN THE PLAN

FM7:Tuggerah Business Park & Railway Levees Survey and Maintenance (Sect 9.2.1.7)
RM7:Orchard Road, Link Road (Sect 9.3.1.7)
RM6:Howes Road, Link Road (Sect 9.3.1.6)
RM11:Elmo Street near Footts Road (Sect 9.3.1.11)
RM10:Burns Road Raising and Culvert Upgrades (Sect 9.3.1.10)
RM9:Burns Road Bridge (Sect 9.3.1.9)
RM5:Chittaway Road near Burns Road (Sect 9.3.1.5)
RM14:Pacific Highway at Dog Trap Gully (Sect 9.3.1.14)
RM4:The Boulevard at Univ Newcastle Ourimbah Campus (Sect 9.3.1.4)
FM5:University Lower Carpark Filling (Sect 9.2.1.5)
RM3:Coachwood Drive North of Mahogany Close (Sect 9.3.1.3)
RM8:Tall Timbers, Link Road (Sect 9.3.1.8)
RM2:Tuggerah Street and Cutrock Road near Pluim Park (Sect 9.3.1.2)
RM1:Tuggerah Street at the Pacific Highway (Sect 9.3.1.1)
RM13:Macdonalds Road near Indigo Place (Sect 9.3.1.13)
RM12:Tapley Road (Sect 9.3.1.12)

Canada Drop Down Ck
Toobys Ck
Ourimbah Ck
Dog Trap Gully
Chittaway Ck
Bangalow Ck
Cutrock Ck

N

FM/RM Floodplain Management Measure - Table 4
Creeks
Ourimbah Creek Catchment

0 1 2 4 km

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Appendix A: Glossary of Terms

Appendix A

APPENDIX A: GLOSSARY

Taken from the Floodplain Development Manual (April 2005 edition)

acid sulfate soils	Are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m^3/s or larger event occurring in any one year (see ARI).
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average Annual Damage (AAD)	Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
Average Recurrence Interval (ARI)	The long term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
caravan and moveable home parks	Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
consent authority	The Council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the Council, however legislation or an EPI may specify a Minister or public authority (other than a Council), or the Director General of DIPNR, as having the function to determine an application.
development	Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act). **infill development:** refers to the development of vacant blocks of land

	that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development. **new development:** refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power. **redevelopment:** refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
disaster plan (DISPLAN)	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse,

	and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves an their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).
flood mitigation standard	The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammetic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.
flood planning area	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the flood liable land concept in the 1986 Manual.
Flood Planning Levels (FPLs)	FPLs are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the standard flood event in the 1986 manual.

flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
flood readiness	Flood readiness is an ability to react within the effective warning time.
flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. **existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain. **future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain. **continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.
freeboard	Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.
habitable room	**in a residential situation:** a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. **in an industrial or commercial situation:** an area used for offices or to store valuable possessions susceptible to flood damage in the event of a

	flood.
hazard	A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Manual.
hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
local drainage	Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.
mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
major drainage	Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves: the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or major overland flow paths through developed areas outside of defined drainage reserves; and/or the potential to affect a number of buildings along the major flow path.
mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
merit approach	The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains.

	The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.
minor, moderate and major flooding	Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood: **minor flooding:** causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded. **moderate flooding:** low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered. **major flooding:** appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	Measures that modify either the flood, the property or the response to flooding.
peak discharge	The maximum discharge occurring during a flood event.
Probable Maximum Flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
probability	A statistical measure of the expected chance of flooding (see AEP).
risk	Chance of something happening that will have an impact. It is measured

	in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	Equivalent to water level. Both are measured with reference to a specified datum.
stage hydrograph	A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	A plan prepared by a registered surveyor.
water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	The horizontal distance in the direction of wind over which wind waves are generated.

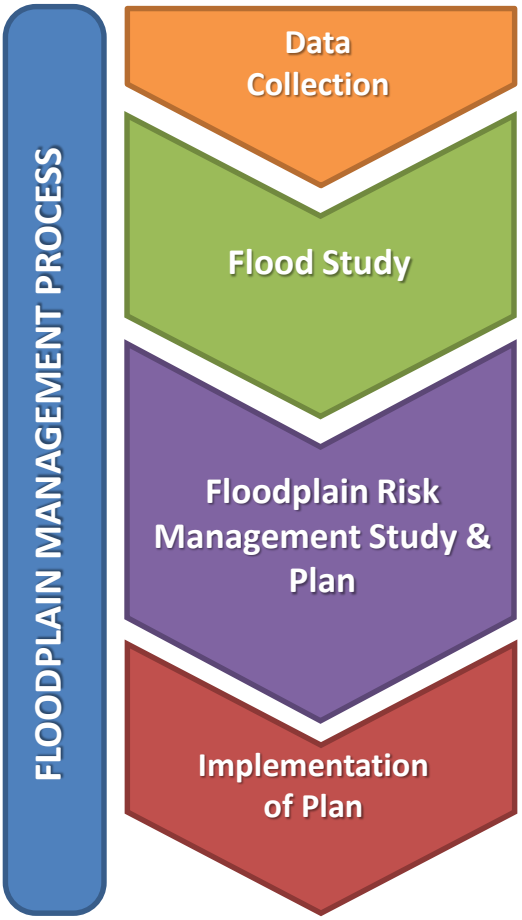
Appendix B: Community Consultation Newsletter and Questionnaire

Appendix B

Ourimbah Creek

Floodplain Risk Management Study & Plan

A Floodplain Risk Management Study and Plan is currently being prepared for Ourimbah Creek. This is the next phase of the Floodplain Risk Management Process after completion of the Ourimbah Creek Flood Study in October 2013. Wyong Shire and Gosford City Councils have appointed WMAwater specialist engineering consultants to do this Study.



The Floodplain Management Process

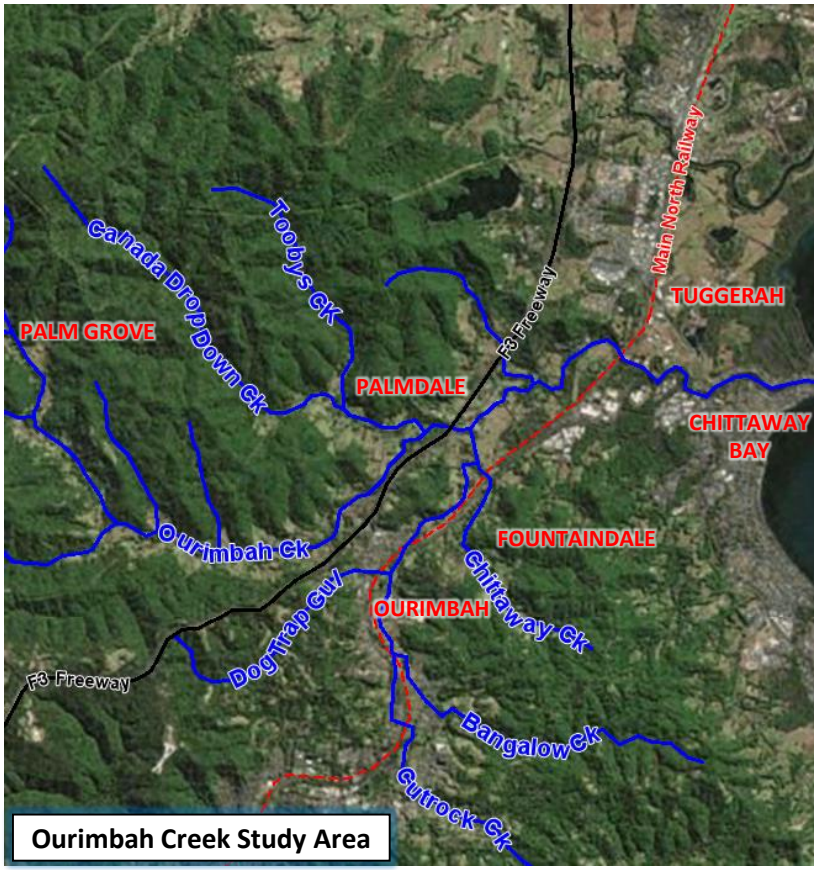
The NSW State Government's Flood Policy aims to reduce the impacts of flooding and flood liability on individual land owners and occupiers, as well as reducing private and public losses resulting from flooding. Under the Policy, local government is responsible for managing flood liable land.

The Policy encourages the development of:

- Solutions to existing flood problems in developed areas
- Strategies for ensuring new development is compatible with the flood hazard and does not create additional flooding problems in existing developed areas.

The State Government's Flood Policy provides technical and financial support for a number of floodplain management activities. Funding for this study was provided from the NSW State Government's Floodplain Management Program, Wyong Shire Council and Gosford City Council.

Ourimbah Creek Study Area and Flood History



Ourimbah Creek Study Area

Flooding in the Ourimbah Creek catchment is primarily due to Ourimbah Creek and its tributaries, however elevated water levels in Tuggerah Lake can also exacerbate flooding in the lower reaches. Ourimbah Creek flows in an easterly direction through Gosford and Wyong Council areas and has a catchment area of approximately 160 km². Historic flood events in the Ourimbah Creek catchment have occurred in 1953, 1974, 1977, 1990, 1992, 2007, 2011 and 2013 with a number of these events leading to over floor flooding.

The largest events on record in the Ourimbah Creek catchment occurred in February 1992 and June 2007. The larger of these two events, the February 1992 flood, inundated hundreds of homes and businesses and caused significant damage throughout the region. The Flood Study estimated this event had an Average Recurrence Interval (ARI) between 50 and 100 years.

More recently, in June 2007 significant flooding of properties was again experienced. The Flood Study estimated this event had an ARI of approximately 20 years.

Ourimbah Creek
Floodplain Risk Management Study & Plan

An important aspect of this Study is devising various flood mitigation options that may help reduce flood risk, liability and damage. The consulting engineers have come up with various mitigation measures. However, we would like to hear your ideas on how we can help reduce flooding in your area. This is where we need your help. Please complete the attached questionnaire and return using the enclosed replay paid envelope.

Flood Risk Mitigation through computer modelling

The Flood Study aimed to understand and determine the nature and extent of flood affectation in the Ourimbah Creek catchment. As part of this work, detailed computer models were established to model flood behaviour in the catchment. One of the benefits of these models is various flood mitigation measures can be tested. This will allow us to determine what works best while ensuring that there are no negative impacts in the surrounding areas.

What mitigation works can help reduce flood risks?

Various types of flood mitigation works are used to reduce the affects of flooding. Not all mitigation measures are appropriate for all areas. For example, levees are often used to exclude flood water due to riverine or creek flooding from flood prone areas. However, these will often increase flood levels outside of the levee as well as stopping local runoff from entering the creek. Accordingly, a detailed investigation of all proposed flood mitigation works must be done using the Flood Study Models. Some examples include:

Levees

Levees are used to exclude flood water from flood prone areas. Levees are often constructed from earth embankments such as those protecting the Tuggerah Business Park area from Ourimbah Creek flooding.


Example earth bank levee

Culverts and bridges

Culverts and bridges allow water to flow under roads, train tracks or similar obstructions. The use of bridges and culverts helps reduce upstream flood levels until the capacity of the structure is exceeded. In some instances it may be beneficial to increase the conveyance capacity of existing culverts to decrease upstream water levels, however the downstream impacts of such works must also be taken into account.

Drains and channels

Drains and channels assist in the removal of floodwaters by increasing the rate at which flow is removed from a flood affected area. These structures are often situated in existing flow paths and are generally either earthen or concrete lined.

Voluntary Purchase

Voluntary Purchase (VP) involves the acquisition of flood affected properties situated in high hazard areas, and demolition of the residence to remove it from the floodplain. The floodplain is then reserved for a more appropriate land use. The New South Wales State Government recognises VP as an effective floodplain risk management measure for existing properties in areas with highly hazardous flood conditions.

Voluntary House Raising

Voluntary House Raising (VHR) has been widely used throughout NSW to significantly reduce flooding of habitable floors particularly in lower hazard flood areas. VHR is recognised as an effective floodplain risk management measure for properties that often experience flood damage.


High Hazard Flooding

Ourimbah Creek
Floodplain Risk Management Study & Plan

Community involvement in this Study is important. The Ourimbah Floodplain Management Committee includes members from Councils, Office of Environment and Heritage, and the State Emergency Services who will oversee this Study. A questionnaire is included with this newsletter so your views and ideas can be included in this Study.

How can I have my say?

A questionnaire is enclosed with this newsletter. Please complete and return to the FREEPOST address in the envelope provided.

Please make sure all surveys are returned before 10th December 2015 or they may not be counted.

If you have additional information you would like to make available for the Study or further comments, please attach them to your questionnaire response or alternatively email to the contacts below.

Feedback from the community will be analysed and considered in this Floodplain Risk Management Study.

The hydraulic models constructed in the Flood Study will be used to assess the impacts of the potential mitigation options raised by the community in more detail and determine if these mitigation ideas are viable. Modelling will also ensure there are no negative impacts in the surrounding areas.

The newsletter/questionnaire provides an opportunity for the community to assist WMAwater engineers in determining potential mitigation works or other management options. If you have any questions about the study or would like more information please contact Council or WMAwater using the contact details below.

Contacts

Robert Baker
Flooding & Drainage Planning Engineer
robert.baker@gosford.nsw.gov.au

Gosford City Council
P.O. Box 21, Gosford NSW, 2250

Tel: 02 4304 7087

Phil Foster
Engineer Hydrology
phil.foster@wyong.nsw.gov.au

Wyong Shire Council
P.O. Box 20, Wyong NSW, 2259

Tel: 02 4350 5745

Zac Richards
Project Engineer
Ourimbah@wmawater.com.au

WMAwater
Level 2, 160 Clarence Street
Sydney, NSW 2000

Tel: 02 9299 2855

Ourimbah Creek
Floodplain Risk Management Study & Plan

Gosford City Council

Wyong Shire Council

Please complete this questionnaire and return to the FREEPOST address in the envelope provided. Please make sure all surveys are returned before 10th December 2015 or they may not be counted.

1. Your Details

(Please note your contact details are optional, will be held confidential and will only be used to contact you for more information regarding this study)

Name:

Address:

Telephone:

Email:

2. How long have you lived in this area?

☐ Years ☐ Months

3. Can we contact you directly for more information?

☐ Yes ☐ No

If 'Yes', what method of contact would you prefer? e.g. telephone, Email etc.

4. Do you think something should be done to reduce flood risk due to Ourimbah Creek and its tributaries (i.e. Bangalow Creek, Cut Rock Creek, Chittaway Creek, Canada Drop Down Creek, Dog Trap Gully etc.)?

☐ Yes ☐ No ☐ Don't Know

5. Please best describe the location/s where you think flood risk should be considered:

Please name nearest street and cross street and other useful information to identify the location of the flood risk. If you are not flood affected by Ourimbah Creek please consider that you may be flood affected by one of its many tributaries including; Bangalow Creek, Cut Rock Creek, Chittaway Creek, Canada Drop Down Creek, Dog Trap Gully etc.

6. At what frequency would you consider flooding "acceptable"?

☐ Annually ☐ 5 years ☐ 10 years ☐ 50 years ☐ 100 years ☐ Never

7. If eligible, would you be interested in a Voluntary Purchase scheme?

☐ Yes ☐ No

8. If eligible, would you be interested in a Voluntary House Raising scheme?

☐ Yes ☐ No

Please note that Questions 6. and 7. are only to obtain an indication of the level of community interest in these schemes. It does not mean your property is flood prone and/or appropriate for these options. Eligibility for VP and VHR are based on the severity of flood hazard. Please feel free to comment on the VP and VHR schemes below.

9. Do you have any of your own ideas to reduce flood risk?

☐ Yes ☐ No

If 'Yes' can you please describe the location of where you think flood risk could be improved (please provide nearest crossroads or known landmarks). A number of pre defined options are presented on the next page that may help with your comments.

As a local resident who may have witnessed flooding, you may have your own ideas about how to reduce flood risks. Which of the following management options would you prefer for the Ourimbah Creek catchment (1 = least preferred, 5 = most preferred)?.

10. Potential Options	Preference
Retarding or detention basins (these temporarily hold water and reduce peak flood flows) - Suggested location/other comments:	**1 2 3 4 5**
Improved flood flow paths such as channels and drains - Suggested location/other comments:	**1 2 3 4 5**
Culvert/bridge enlarging - Suggested location/other comments:	**1 2 3 4 5**
Pit and pipe upgrades - Suggested location/other comments:	**1 2 3 4 5**
Levee banks or flood walls - Suggested location/other comments:	**1 2 3 4 5**
Strategic planning and flood related development controls - Suggested location/other comments:	**1 2 3 4 5**
Education of the community, providing greater awareness of potential hazards - Suggested location/other comments:	**1 2 3 4 5**
Flood forecasting, flood warnings, evacuation planning and emergency response measures - Suggested location/other comments:	**1 2 3 4 5**

Other (please specify any other options you think are suitable):
Please use as many details as possible to describe how flood risk may be reduced.

Appendix C: New Intercity Fleet Maintenance Facility – Community Notification May/June 2016

Appendix C

NSW GOVERNMENT Transport for NSW

NSW MAKING IT HAPPEN

New Intercity Fleet Maintenance Facility

MAY/JUNE 2016

COMMUNITY NOTIFICATION – REF OVERVIEW

Artist's impression of maintenance facility from the new access at Orchard Road

About the project

New Intercity Fleet

The NSW Government is delivering a New Intercity Fleet to replace the trains carrying customers from Sydney to the Central Coast, Newcastle, the Blue Mountains and the Illawarra.

This next-generation fleet of trains will give long distance customers a more comfortable travelling experience. Other customers will also benefit from this significant investment. The new trains will stop at many busy Sydney interchanges such as Central and Strathfield as well as enabling a number of improvements to future train operations.

A number of enabling infrastructure projects will be required across the wider rail network as part of the New Intercity Fleet program. Details of this work is in development and will be done under separate planning assessments.

The new trains will come into service progressively, with the first trains anticipated to be delivered in 2019 and the rest of the fleet being delivered through to 2024.

The trains will be safe, comfortable and accessible, providing an appealing environment for customers during longer journeys.

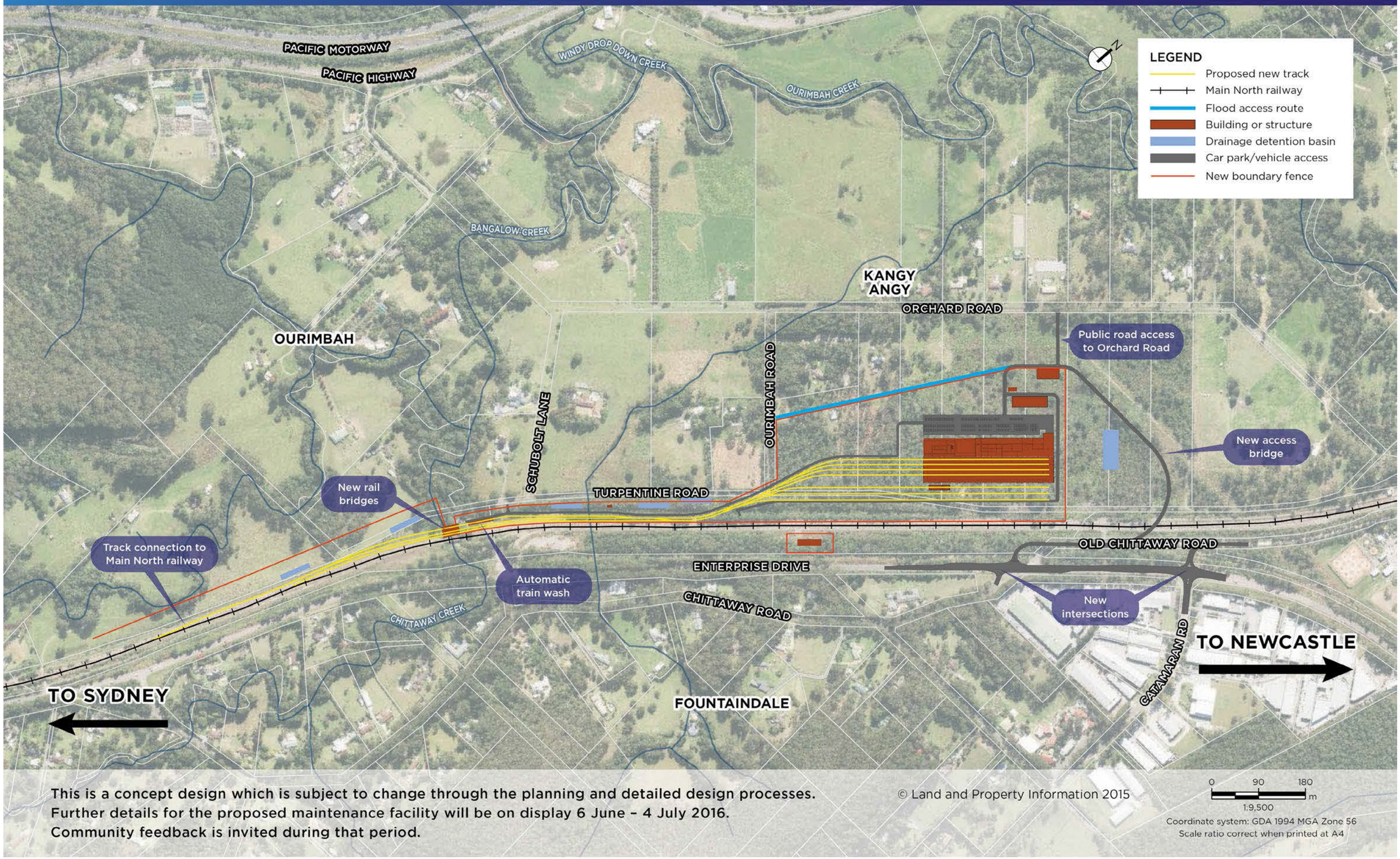
Maintenance facility

A new purpose-built train maintenance facility will be built at Kangy Angy to service and maintain the new fleet of trains, subject to planning approval. The location provides easy access, from the Northern Line.

This brochure outlines the current planning for the new facility and provides details about the proposed site and the Review of Environmental Factors (REF). It also shows how you can have your say during the public display of the Review of Environmental Factors.

For more information call **1800 684 490**
email **projects@transport.nsw.gov.au** or visit **transport.nsw.gov.au/projects**

PROPOSED MAINTENANCE FACILITY



This is a concept design which is subject to change through the planning and detailed design processes.
Further details for the proposed maintenance facility will be on display 6 June – 4 July 2016.
Community feedback is invited during that period.

0 90 180 m
1:9,500
Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A4

NSW GOVERNMENT Transport for NSW

How was the site chosen?

Transport for NSW considered a number of locations alongside existing railway lines across the network for their suitability, as well as existing maintenance facilities.

The Central Coast was identified as the ideal location as the new trains will regularly operate on the Main Northern Line.

Kangy Angy was identified as the preferred site based on operational, environmental, land ownership and construction considerations, including the requirement to have the facility in operation for the introduction of the new fleet.

More information about the process undertaken by Transport for NSW to select the Kangy Angy site will be detailed in the Review of Environmental Factors.

About the proposal

Details of the proposed maintenance facility site are provided in the map opposite.

The purpose built facility will provide a high standard of maintenance for the new state-of-the-art intercity train fleet. Designed to accommodate trains of up to 205 metres in length, the maintenance building will hold four trains, with the ability to expand to five in the future, if required.

New jobs will be created during the construction phase of the project. Flow-on economic benefits are expected for the local community during the operation of the facility. Work force apprenticeships and strategies on how to support local small to medium enterprises and social not-for-profit enterprises will be put in place.

The maintenance facility will include:

- a maintenance building including a stores area for carrying out general maintenance and to hold the necessary spare parts to maintain the new trains
- offices and amenities to house maintenance and office staff, including staff parking areas
- a wheel lathe building to maintain the train wheel sets
- train decanting and cleaning facilities
- an automated train wash building to wash trains
- a yard area with tracks to allow for the efficient movement of trains within the site for maintenance activities
- power supply equipment for the facility.

Associated project elements to support the new maintenance facility include:

- construction of three track bridge structures to facilitate train entry/exit into the facility from the existing main line
- new bridge over the railway to provide access to the facility. The bridge will connect Enterprise Drive to Orchard Road and offer an alternative access for local residents in times of flood
- upgrade to Enterprise Drive and Catamaran Road intersection and revised access to Chittaway Road from Enterprise Drive
- installation of high voltage power, stormwater detention, sewer, water and fire services infrastructure.

Construction

Construction of the maintenance facility is due to start in early 2017 and is planned to be completed in late 2019. Construction would consist of the following stages:

- project enabling work including utility diversions, building new access roads, bridge and general roadwork
- main construction work.

Review of Environmental Factors

A Review of Environmental Factors (REF) is an environmental assessment that is required to obtain project approval under Part 5 of the NSW *Environmental Planning and Assessment Act 1979*.

A REF examines the significance of likely environmental impacts of a proposal. It identifies the measures required to mitigate any adverse impacts to the community or environment during the construction and operation phases of a project.

A REF which includes project information, concept plans and specialist impact assessment studies will be on display for public comment from 6 June 2016 for four weeks.

Specialist impact assessment studies carried out for the project include:

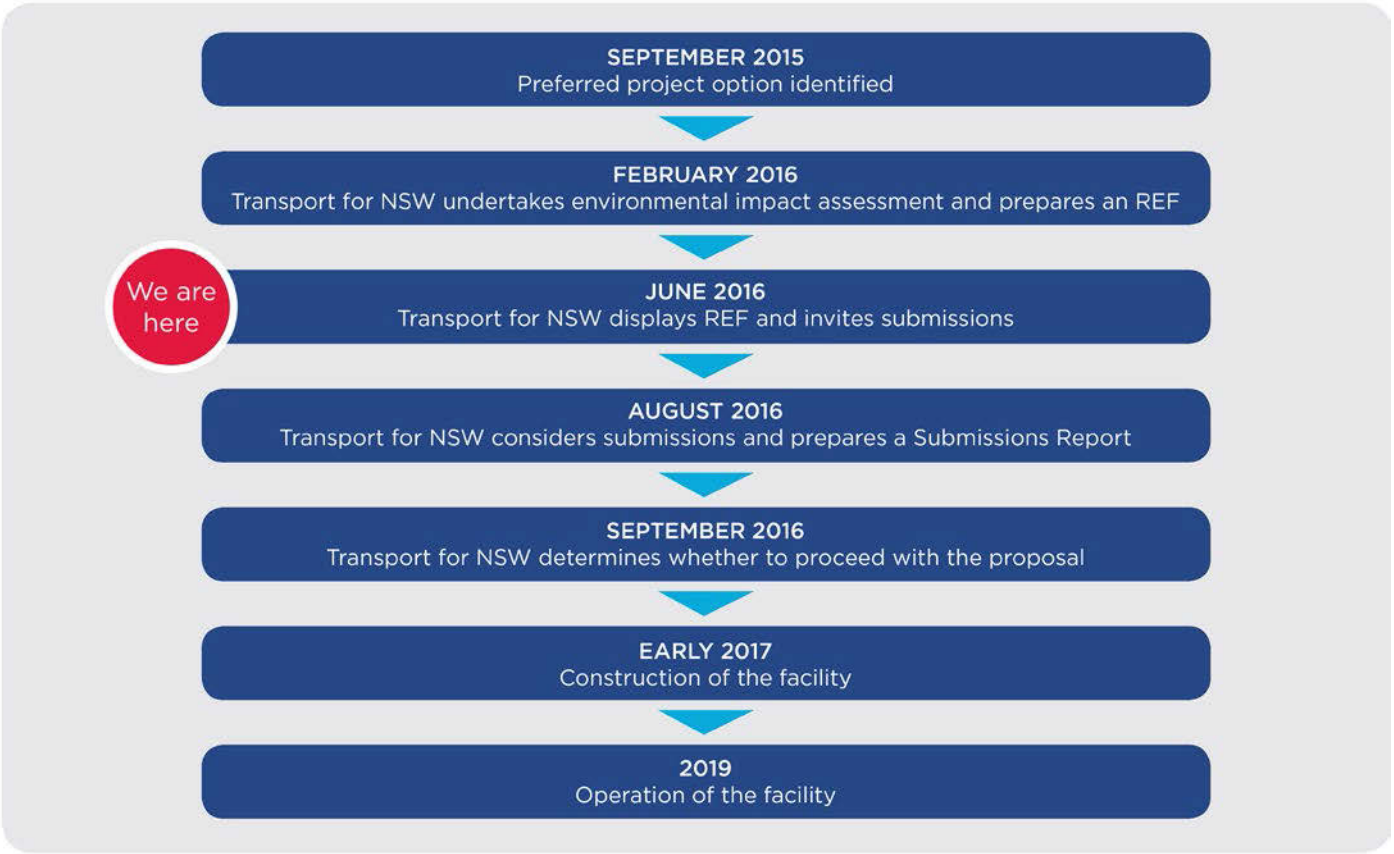
- biodiversity
- noise and vibration
- visual and landscape character
- Aboriginal heritage
- non-Aboriginal heritage
- traffic and transport
- water quality, hydrology and drainage
- air quality
- social
- groundwater.

The key potential impacts identified in the REF and proposed high level mitigation include:

Subject	Proposed key potential impact	Proposed key mitigation
Biodiversity	Loss of existing vegetation, some of which has been identified as threatened species and endangered ecological communities	Preparation of a vegetation management plan for the construction phase and the development of a biodiversity offset plan
Noise and vibration	Noise impacts during both construction and operation of the project	Preparation of noise and vibration management plans for construction and operation phases
Landscape and visual character	Changes to the rural-residential nature of the existing environment	Retaining existing vegetation where possible and undertaking revegetation with native species for visual screening
Traffic and transport	Increase in light and heavy vehicle use on local roads during construction	Preparation of a construction traffic management plan
Hydrology, flooding and groundwater	Potential for impact to both local flood levels and the facility by the 1:100 year flood event.	Preparation of a detailed flood impact assessment and design of the project to be out of the 1:100 year flood zone.
Aboriginal heritage	Impact currently undiscovered Aboriginal artefacts within the site	Preparation of an Aboriginal Cultural Heritage Assessment Report including further Aboriginal community consultation and archaeological test excavations

Specific mitigation plans outlining detailed mitigation measures will be prepared during the detailed design phase of the project.

The planning process



Have your say

As design and planning progresses, this is our first opportunity to provide more details to the community about the project. We want to continue to work with the community to understand local issues and identify appropriate mitigation measures.

The Review of Environmental Factors (REF) and concept design for the proposed maintenance facility will be on public display between **6 June to 4 July 2016**.

You can view the REF and project information at the following locations:

Wyong City Council Civic Centre
16 Hely Street, Wyong
Opening Hours: 8:30am to 5.00pm Monday to Friday

Tuggerah Library and Council Services
50 Wyong Road, Tuggerah
Opening Hours: 9:00am to 5:30pm Monday to Friday
9.00am to 3.00pm Saturday

Transport for NSW
Level 5, Tower A, Zenith Centre,
821 Pacific Highway, Chatswood
Opening Hours: 8:30am to 5.00pm Monday to Friday

Department of Premier and Cabinet Office
Level 3, 131 Donnison Street, Gosford
Opening Hours: 9.00am to 5.00pm Monday to Friday

Or visit the project website
www.transport.nsw.gov.au/projects

Community information sessions

Transport for NSW will be holding two community information sessions during the public display period. These sessions will provide an opportunity for interested members of the community to find out more about the project and the REF. Members of the project team will be available to answer your questions.

The details of these sessions are listed below:

Saturday 18 June
Drop in any time between **10am to 1pm**
Central Coast Steiner School
45 Catamaran Road, Fountaindale NSW

Thursday 23 June
Drop in any time between **4pm to 7pm**
Central Coast Steiner School
45 Catamaran Road, Fountaindale NSW

Formal submissions

Feedback on the project can be given by filling in a form at the community information sessions or by:

- emailing **projects@transport.nsw.gov.au**
- visiting **haveyoursay.nsw.gov.au**
- writing to **New Intercity Fleet Maintenance Facility**
  Principal Manager Environmental Impact Assessment
  Transport for NSW
  Locked Bag 6501
  St Leonards NSW 2065

All submissions must be in writing and received by 5pm on Monday 4 July 2016.

Next Steps

Following the close of the public display period, Transport for NSW will consider all submissions received from the community and respond to this feedback.

A Submissions Report will be prepared by Transport for NSW and made publically available. The project team will write to those who made a submission to advise them when the report is available.

Subject to planning approval, preliminary construction work on utilities and road access including the new bridge is expected to begin in early 2017.

The project team is committed to keeping the local community updated on the progress of planning and construction of the new maintenance facility.

Contact us

For more information:
email **projects@transport.nsw.gov.au**
call **1800 684 490**
or visit **transport.nsw.gov.au/projects**

This document contains important information about public transport projects in your area. If you require the services of an interpreter, please contact the Translating and Interpreting Service on **131 450** and ask them to call Transport Projects on **(02) 9200 0200**. The interpreter will then assist you with translation.

Appendix D: Flood Mitigation Options – Impact Mapping

Appendix D

FIGURE D1
PEAK FLOOD LEVEL IMPACT
OPTION FM3
MILLS STREET INDUSTRIAL PRECINCT LEVEE
1% AEP EVENT

N

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 0.1 0.2 0.4 0.6 km

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FIGURE D2
PEAK FLOOD LEVEL IMPACT
OPTION FM4
UNIVERSITY OF NEWCASTLE OURIMBAH CAMPUS
LOWER CARPARK LEVEE
1% AEP EVENT

N

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 25 50 100 150 200 m

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FIGURE D3
PEAK FLOOD LEVEL IMPACT
OPTION FM6
CANNTREE ROAD LEVEE
0.5% AEP EVENT

N

Canntree Rd Levee

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 100 200 400 600 m

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FIGURE D4
PEAK FLOOD LEVEL IMPACT
OPTION FM8
BAILEYS ROAD DIVERSION CHANNEL
1% AEP EVENT

N

Baileys Rd Diversion Channel

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 0.25 0.5 1 1.5 km

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FIGURE D5
PEAK FLOOD LEVEL IMPACT
OPTION FM9
INCREASING LEES BRIDGE CONVEYANCE CAPACITY
0.5% AEP EVENT

N

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 100 200 400 600 m

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FIGURE D6
PEAK FLOOD LEVEL IMPACT
OPTION FM13
CUT ROCK CREEK BASIN
1% AEP EVENT

N

Cut Rock Creek Basin

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 0.25 0.5 1 1.5 km

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FIGURE D7
OPTION FM14
COMBINED OPTION FM13 AND FM8
TUGGERAH ST AND CUTROCK RD NEAR PLUIM PARK
1% AEP EVENT

N

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

0 100 200 400 m

A B C D E F G

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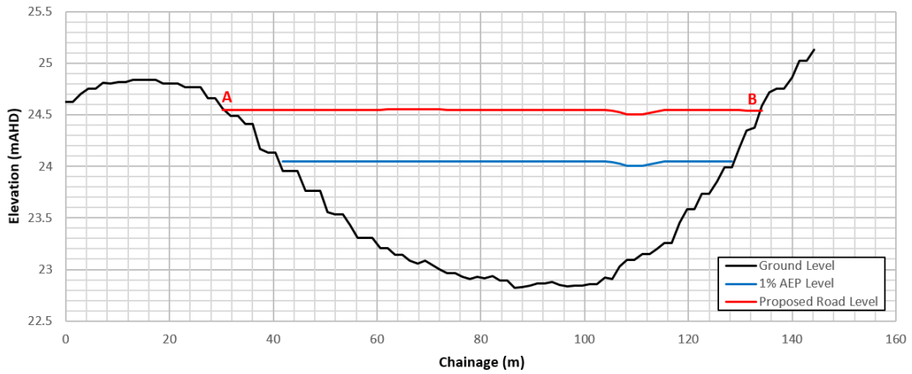
Appendix E: Flood Mitigation Options – Concept Designs

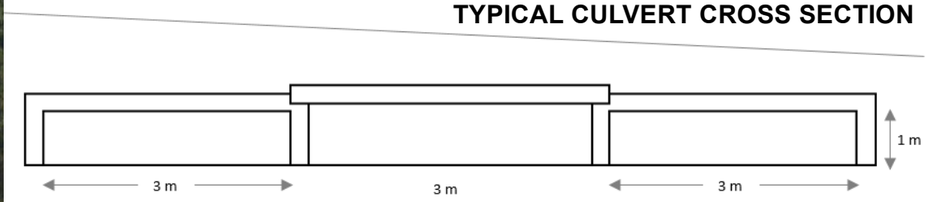
Appendix E

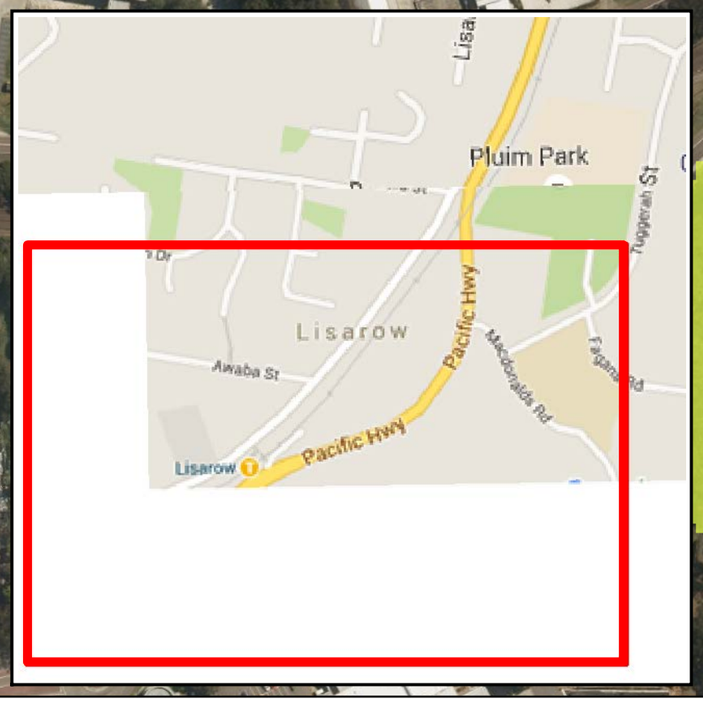
FIGURE E1
OPTION RM1
IMPROVEMENTS TO FLOOD ACCESS ROAD
TUGGERAH ST AT PACIFIC HIGHWAY

MACDONALDS RD ROAD RAISING



TYPICAL CULVERT CROSS SECTION





A

B

Updated Culverts
Road Raised

Change in Flood Level (m)

< -0.3
-0.3 - -0.2
-0.2 - -0.1
-0.1 - -0.05
-0.05 - -0.02
No Impact
0.02 - 0.05
0.05 - 0.1
0.1 - 0.2
0.2 - 0.3
> 0.3
No Longer Flooded
Newly Flooded

N

0 25 50 100 150 200 m

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FIGURE E2
OPTION FM14
IMPROVEMENTS TO FLOOD ACCESS ROAD

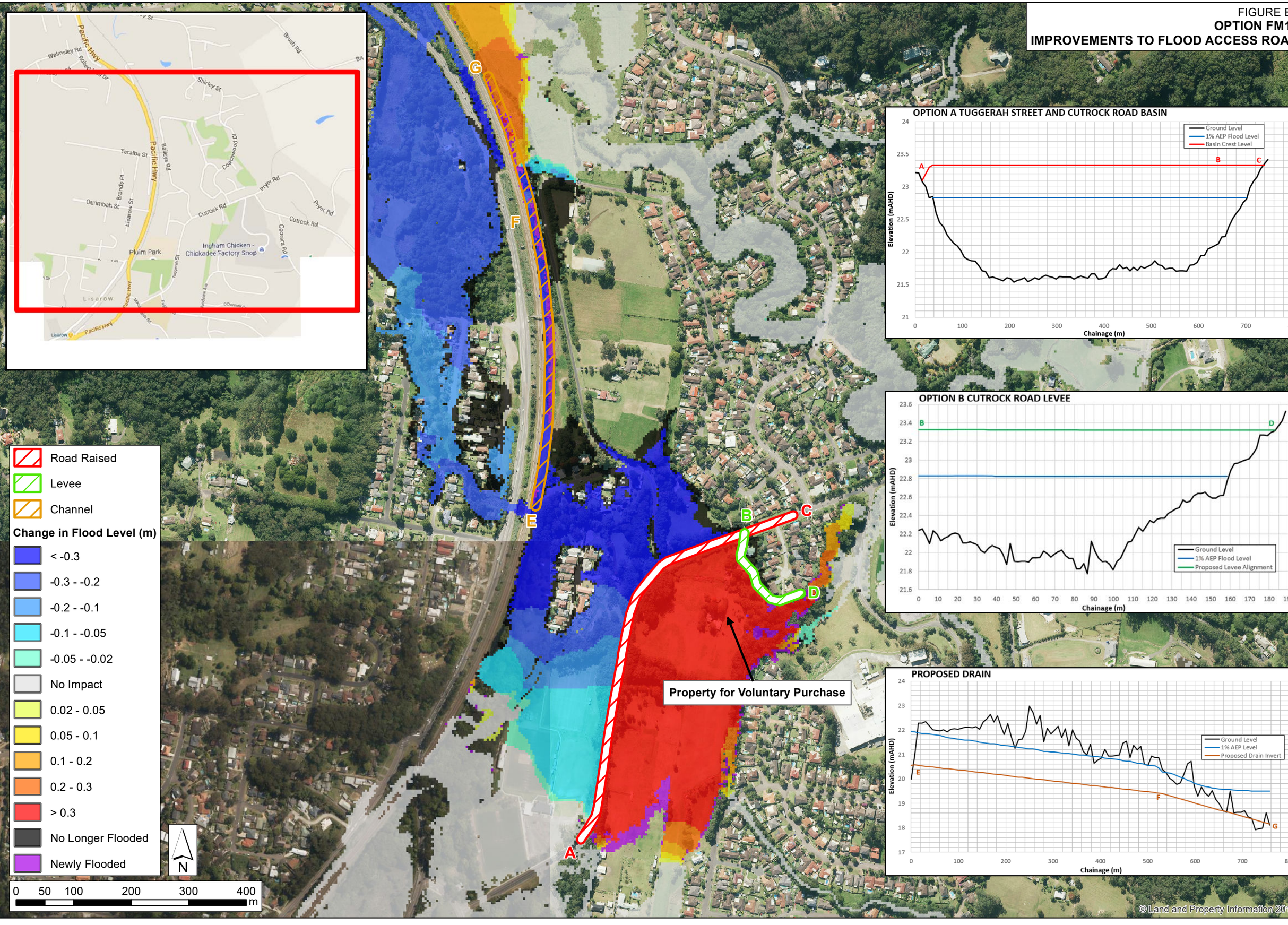

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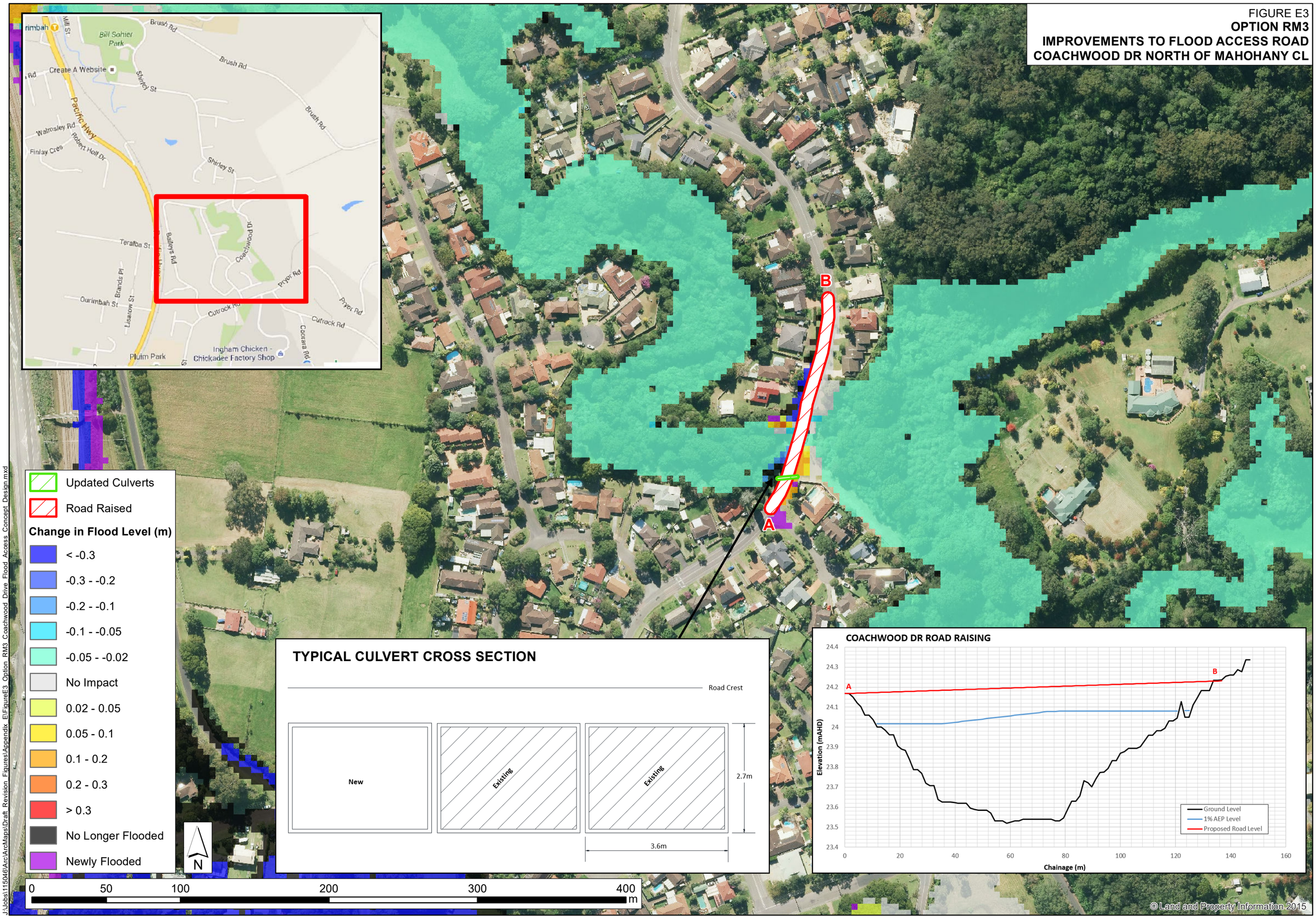
FIGURE E3
OPTION RM3
IMPROVEMENTS TO FLOOD ACCESS ROAD
COACHWOOD DR NORTH OF MAHOHANY CL



Updated Culverts

Road Raised

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

N

0 50 100 200 300 400 m

TYPICAL CULVERT CROSS SECTION

COACHWOOD DR ROAD RAISING

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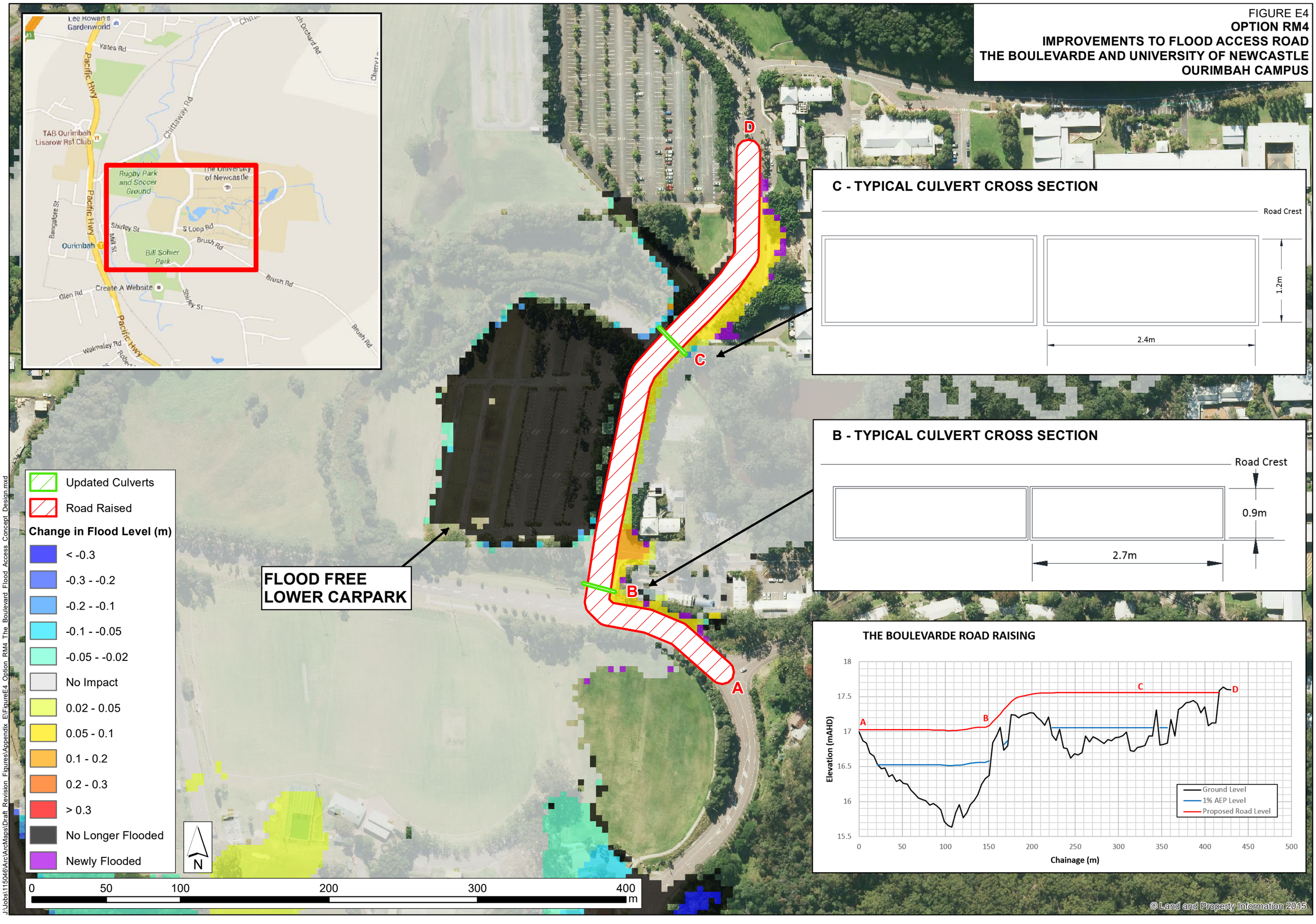
FIGURE E4
OPTION RM4
IMPROVEMENTS TO FLOOD ACCESS ROAD
THE BOULEVARDE AND UNIVERSITY OF NEWCASTLE
OURIMBAH CAMPUS



C - TYPICAL CULVERT CROSS SECTION

B - TYPICAL CULVERT CROSS SECTION

THE BOULEVARDE ROAD RAISING

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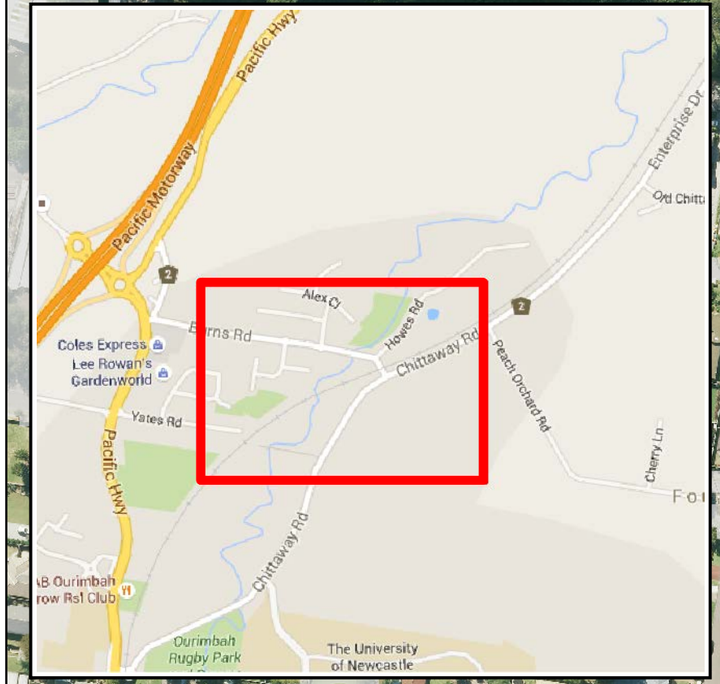
FIGURE E5
OPTION RM5
IMPROVEMENTS TO FLOOD ACCESS ROAD
CHITTAWAY RD NEAR BURNS RD



Road Raised

Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

N

0 50 100 200 300 400 m

CHITTAWAY RD ROAD RAISING

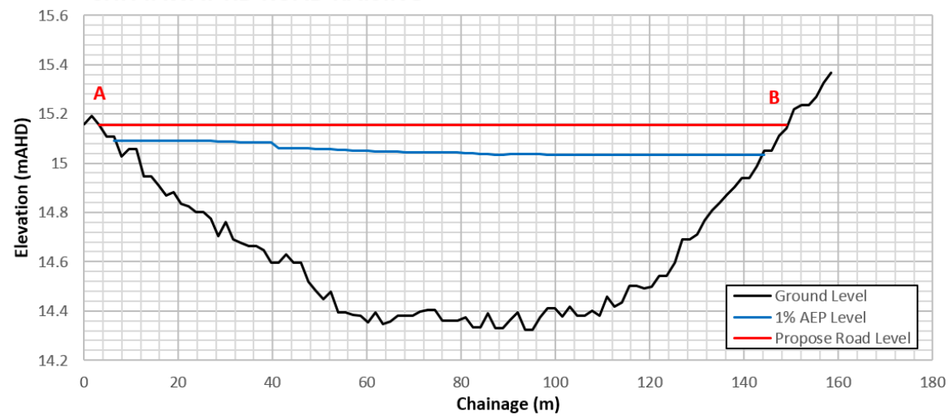


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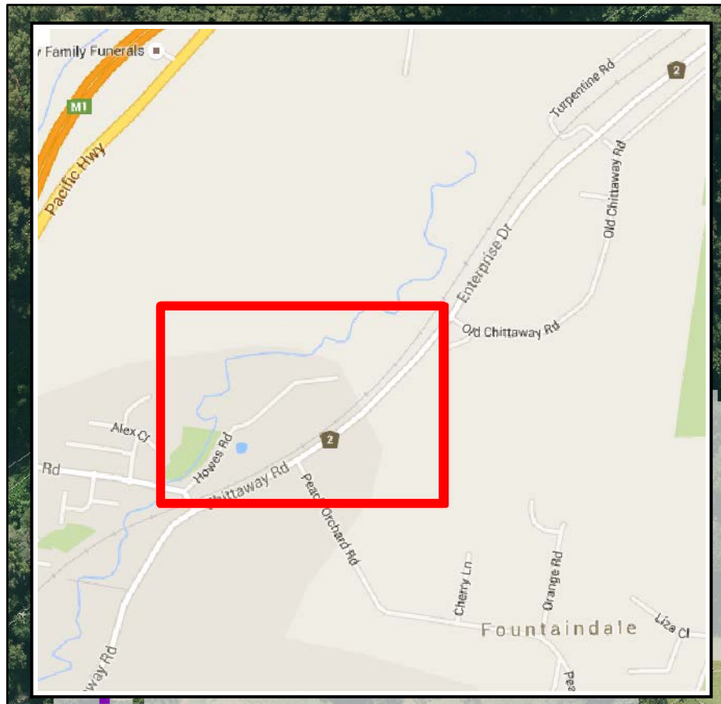
FIGURE E6
OPTION RM6
IMPROVEMENTS TO FLOOD ACCESS ROAD
ENTERPRISE DR NEAR OLD CHITTAWAY RD
HOWES ROAD LINK



A
B
C

Proposed Access Road
Levee

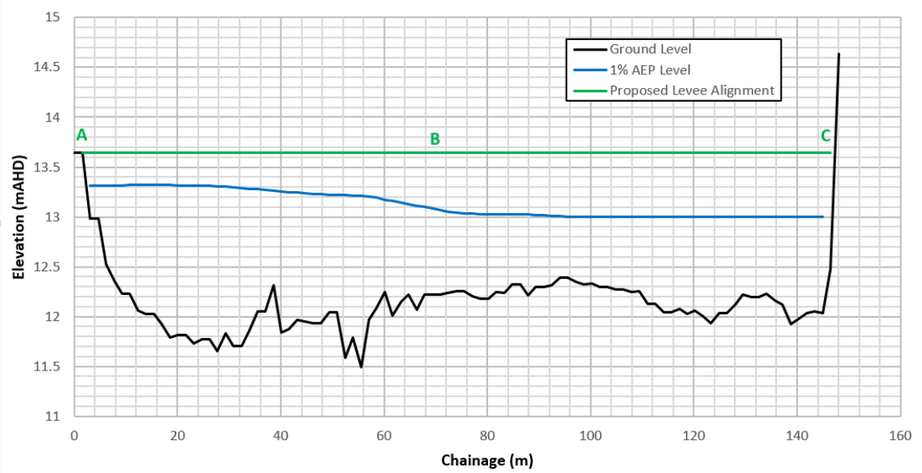
Change in Flood Level (m)

- < -0.3
- -0.3 - -0.2
- -0.2 - -0.1
- -0.1 - -0.05
- -0.05 - -0.02
- No Impact
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- > 0.3
- No Longer Flooded
- Newly Flooded

N

0 50 100 200 300 400 m

HOWES RD LEVEE



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Appendix F: Consultation Letters

Appendix F

Roads and Maritime Services
205 New England Highway
Hexham NSW 2322

Letter16062015_Ourimbah_FRMSP_RMS_Information_Request.docx

16 June 2016

Attention: Craig Walker

Dear Craig,

Re: Ourimbah Creek Catchment – Floodplain Risk Management Study and Plan

WMAwater are currently undertaking a Floodplain Risk Management Study and Plan (FRMSP) for the Ourimbah Creek catchment on behalf of Wyong and Gosford Councils (Council). The aim of this study is to identify and ameliorate flood risk. There are three main issues that RMS may be able to provide advice on. These are:

1. **Early Warning Notification of Road Closures -** The potential for utilising RMS Variable Messaging System (VMS) or addition of new signage on the Pacific Highway at Ourimbah to provide early notification of road closures on Burns Road, Chittaway Road and Shirley Street due to flooding.

2. **Macdonalds Street Upgrade -** Is information available relating to the new design alignment and level of the Macdonalds Street exit with the proposed upgrade of Pacific Highway HW10, Ourimbah Street to Parsons Road, Lisarow?

3. **RMS Stream Gauges –** Council have noted that RMS have installed stream gauges on Cut Rock and Bangalow Creeks to record base flow for the above mentioned upgrade of the Pacific Highway. Can these gauges be left in situ for use by Council for automatic road closures?

Further details for the above listed questions are provided below.

Early Warning Notification of Road Closures

Three roads that are frequently flooded have been identified as posing a significant risk to motorists during flood. These roads are:

- Burns Road;
- Chittaway Road; and
- Shirley Street.

The location of these roads are presented in Image 1 and are numbered accordingly. The NSW SES make numerous rescues every year on these roads, and in particular, on Burns Road.

Image 1: Frequently Flooded Roads

As part of this FRMSP, WMAwater are undertaking a feasibility assessment to determine the viability of utilising RMS VMS to notify motorists of road closures on these roads due to flooding. It is hoped that motorist will then make informed decisions and select a different route, thus avoiding these roads during periods of high flow. Currently, these roads are closed during flood, however motorists have been frequently ignoring warning signs and road closures and attempting to pass flooded roads.

It is envisaged that a stream gauge on Cut Rock Creek could be used to send automatic notification using telemetry to RMS once a set threshold has been exceeded. RMS could then apply a warning to motorists using the VMS.

In preliminary discussions with RMS it was noted that there could be various issues with using VMS, particularly relating to warning priority. WMAwater are seeking advice on whether this system could work and what issues there are to be overcome.

Additionally, if use of the VMS is not recommended, would RMS allow Council to install their own warning signs that could be automatically triggered when required?

Macdonalds Street Upgrade

RMS are currently undertaking the Upgrade of Pacific Highway HW10, Ourimbah Street to Parsons Road, Lisarow. A study undertaken by JACOBS (October 2014) indicates that the Macdonalds Street exit is to be upgraded (see Image 2).

The current road alignment between the Highway and Cut Rock Creek is frequently flooded. Is there any new information available about the alignment of this road, particularly related to the road crest level and the flood affectation of this exit?

Image 2: Macdonalds Street Exit Upgrade

Figure 1-2b | Overview of the road design

RMS Stream Gauges

Council have noted that RMS have installed stream gauges on Cut Rock and Bangalow Creeks to record base flow for the above mentioned upgrade of the Pacific Highway. Can these gauges be left in situ for use by Council for automatic road closures as per the methods outlined in the 'Early Warning Notification of Road Closures' section?

If any information related to the location of and data collected by these gauges could be provided that would be helpful.

Yours Sincerely,
WMAwater

Zac Richards
Associate

New Intercity Fleet Maintenance Facility
Principal Manager Environment Impact Assessment
Transport for NSW
Locked Bag 6501
St Leonards NSW 20165

17 June 2016

Attention: Principal Manager Environment Impact Assessment

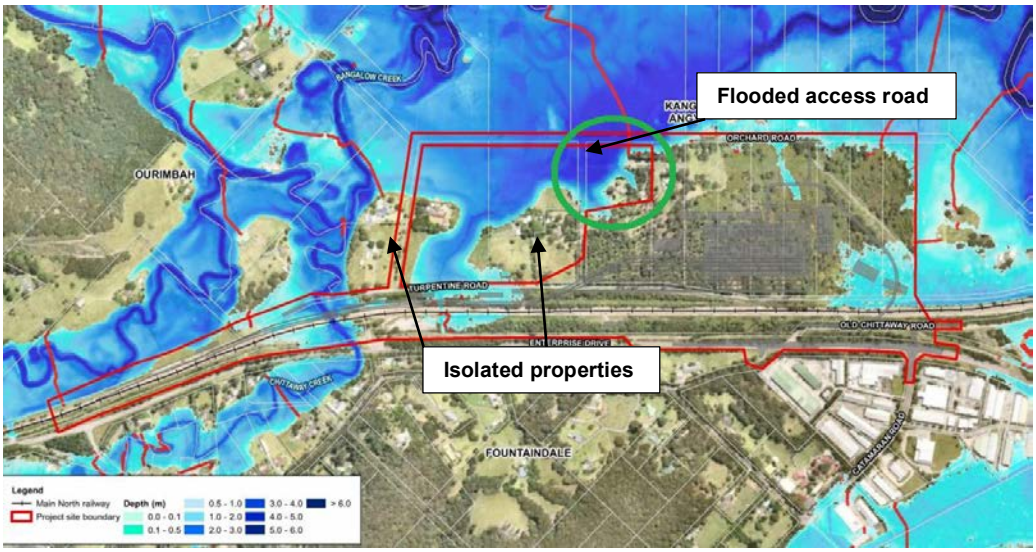
Re: New Intercity Fleet Maintenance Facility – Flooding Considerations

WMAwater are currently undertaking a Floodplain Risk Management Study and Plan (FRMSP) for the Ourimbah Creek catchment on behalf of Wyong and Gosford Councils (Council). The aim of this study is to identify and ameliorate flood risk.

WMAwater have reviewed the New Intercity Fleet Maintenance Facility (the Facility) Report and would like to provide the following feedback:

1. The proposed 'New access bridge' that connects Enterprise Drive and Orchard Road is beneficial from a flood risk mitigation perspective as it provides flood free access for events up to and including the 1% AEP to properties on Orchard Road.

2. Even with construction of the 'New access bridge', properties on Turpentine and Ourimbah Roads will still be isolated during flood as the intersection of Orchard and Ourimbah Roads is flooded by in excess of 2 m during the 0.2EY event (see image below).



WMAwater Pty Ltd (Formerly Webb McKeown and Associates) **ABN 14 600 315 053**

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Website: wmawater.com.au

WMAwater request that consideration is given to road raising or providing alternative access routes for properties on Turpentine and Ourimbah Roads as part of the proposed Facility. Significant benefit could be achieved in terms of flood risk mitigation for properties on these roads if improved flood access is provided.

Yours Sincerely,
WMAwater

Zac Richards
Associate

Contact Details:
Email: richards@wmawater.com.au
Phone: 9299 2855

Roads and Maritime Services
Services Central Coast Office
Locked Bag 2030
Hexham NSW 2322

20 June 2016

Attention: Craig Leckie

Dear Craig,

Re: Ourimbah Creek Catchment – Floodplain Risk Management Study and Plan

WMAwater are currently undertaking a Floodplain Risk Management Study and Plan (FRMSP) for the Ourimbah Creek catchment on behalf of Wyong and Gosford Councils (Council). The aim of this study is to identify and ameliorate flood risk.

One of the main sources of flood risk in the Ourimbah Catchment is flooded roads. Numerous roads throughout the Catchment are frequently flooded by high hazard flows. As part of this FRMS&P, WMAwater have identified roads which are of key concern. The existing Macdonalds Road exit is one of these roads.

The Pacific Highway Upgrade – Ourimbah Street to Parsons Road, Lisarow, Draft REF submission report (October 2015) indicates that the existing Pacific Highway exit at Macdonalds Road is to be replaced by an exit directly onto Tuggerah Street. WMAwater have examined flood affectation of the proposed exit based on the above mentioned report and make the following comments:

- The exit is flooded in the 0.5EY event and potentially more frequent events not modelled.
- In the 0.2EY flood the exit experiences depths > 0.5 m and velocities of ~1 m/s. Based on new guidelines *(Managing the floodplain: a guide to best practice in flood risk management in Australia, Australian Government, 2013)* the flood hazard at this exit is classed as H3 which means that it is unsafe for all vehicles.
- In the 1% AEP flood the exit experiences depths > 1.8 m and velocities >1.5 m/s, placing flooding of the proposed exit in the H5 flood hazard classification. This poses an extreme risk to motorists.

In light of the above, it is noted that motorists using the proposed Pacific Highway Tuggerah Street exit at times of flood are subject to high levels of risk. Due to the frequency at which this exit is flooded, risk to life is particularly high.

WMAwater Pty Ltd (Formerly Webb McKeown and Associates) **ABN 14 600 315 053**

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Website: wmawater.com.au

WMAwater recommend that the proposed Tuggerah Street exit be examined as part of the detailed design for Pacific Highway upgrade between Ourimbah Street and Parsons Road. Providing flood free access for the 1% AEP event at this location will significantly reduce flood risk within the catchment.

Yours Sincerely,
WMAwater

Zac Richards
Associate

Contact Details:
Email: richards@wmawater.com.au
Phone: 9299 2855

Appendix G: Copy of WMAwater – Review of Bangalow Creek and Cut Rock Creek Floodplain Management Plan – Area G2, December 2014 (Reference 10) and Summary from Bangalow Creek & Cut Rock Creek Floodplain Management Plan (Reference 11)

Appendix G

Review of Bangalow Creek and Cut Rock Creek Floodplain Management Plan – Area G2

wma water

DECEMBER 2014

Level 2, 160 Clarence Street
Sydney, NSW, 2000

Tel: 9299 2855
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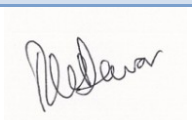
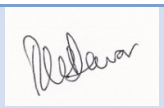
Review of Bangalow Creek and Cut Rock Creek Floodplain Management Plan – Area G2

DECEMBER 2014

Project **Review of Bangalow Creek and Cut Rock Creek Floodplain Management Plan – Area G2**	Project Number **111076**
Client Gosford City Council	**Client's Representative** Sue Stanford - Flooding & Drainage Planning Engineer
Authors Richard Dewar	**Prepared by** 
Date 11 December 2014	**Verified by** 

Revision	Description	Date
1	Final Draft	April 2014
2	Final	11 December 2014

REVIEW OF BANGALOW CREEK AND CUT ROCK CREEK FLOODPLAIN MANAGEMENT PLAN – AREA G2

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FOREWORD

The NSW State Government's Flood Policy provides a framework to ensure the sustainable use of floodplain environments. The Policy is specifically structured to provide solutions to existing flooding problems in rural and urban areas. In addition, the Policy provides a means of ensuring that any new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist Councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the Government through four sequential stages:

1. ***Flood Study***
   - Determine the nature and extent of the flood problem.
2. ***Floodplain Risk Management Study***
   - Evaluates management options for the floodplain in respect of both existing and proposed development.
3. ***Floodplain Risk Management Plan***
   - Involves formal adoption by Council of a plan of management for the floodplain.
4. ***Implementation of the Plan***
   - Construction of flood mitigation works to protect existing development, use of Local Environmental Plans to ensure new development is compatible with the flood hazard.

This report provides a review and update of Stage 3 of the above; namely Area G2 – Pluim Park/Tall Timbers estate/Mannings Road of the 1997 Bangalow Creek and Cut Rock Creek Floodplain Management Plan as an interim measure until a more detailed assessment of the catchment can be undertaken in a Floodplain Risk Management Study.

The Ourimbah Creek catchment, of which Cut Rock Creek is a tributary, was recently reviewed by Wyong Shire and Gosford City Councils following receipt of a government grant to undertake a Flood Study. However it may be in excess of 12 months before a Floodplain Risk Management Study & Plan for this area is reviewed as part of the floodplain risk management program process as detailed above.

This report provides the basis for the interim management of flood prone lands within Area G2 of the 1997 Bangalow Creek and Cut Rock Creek Floodplain Management Plan based upon existing flood information as of the date of this review. No additional investigation of surrounding land included within the 1997 Bangalow Creek and Cut Rock Creek Floodplain Management Plan was undertaken as part of this review.

EXECUTIVE SUMMARY

Gosford City Council is continually reviewing previously completed floodplain management plans within its LGA. The present study is a desktop review of the 1997 Bangalow Creek and Cut Rock Creek Floodplain Management Plan (Area G2 – Pluim Park/Tall Timbers estate/Mannings Road) and was undertaken due to the inability for residents of the Tall Timber estate to ingress or egress the estate during frequent storm events experienced on several occasions in 2011, 2012 and 2013.

The outcome is reported as an addendum to the current Floodplain Management Plan and is viewed as an interim measure to ascertain whether any short term measures could be implemented to reduce the risk to life. In the long term, it is Council's intention to review the 1997 Floodplain Management Study and Plan as resources become available.

The study area is located immediately upstream of the Pacific Highway at Lisarow and includes Pluim Park, the 14 houses within the Tall Timbers estate and the 6 houses on Mannings Road.

The work included a review of all flood related information and the issuing of a newsletter and questionnaire. This was followed by a public workshop held on 30th January 2012 and subsequent investigation and review of the outcomes of both the questionnaire and workshop. An additional public workshop was convened on 17th June 2013 to discuss the contents of the Draft Addendum.

The main outcomes of this review are:

1. The access road from Tuggerah Street to Tall Timbers estate is privately owned. The road level is not considered to be in accordance with current best practice in floodplain management due to its vulnerability to be cut in minor frequent storm events (potentially several times a year). Construction of an upgraded bridge or high level footbridge on privately owned land to improve access and funded by Council does not conform with Council's responsibilities. The responsibility for upgrading the road should rest with the private owners of the access road. Raising of the access road would provide benefit in minor frequent storm events only and may place people at greater risk in another part of the floodplain.

2. The proposed access via the railway maintenance track during rare flood events was not formalized at the time of development of the site and the area has since been fenced off to the public. Council has approached Railcorp regarding permission for Council to construct an elevated pedestrian/cycleway alongside the railway line on Railcorp land to provide flood free pedestrian access from the estate.

   A pedestrian footbridge over the railway line near Ourimbah Street Lisarow has also been considered however Railcorp have safety concerns.

3. All past works on Pluim Park have been approved and any addition of topsoil has been undertaken in a manner that complies with Council's conditions of development consent. All development assessments for Pluim Park ensure works do not exacerbate flooding. Council is

liaising with the Central Coast Football Club to incorporate works to reduce the volume of topsoil reported as washing off the site during frequent storm events.

4. Council does not undertake creek maintenance on privately owned land where there is no easement in place. Council would only consider such works if a life threatening or similar situation arose. Dredging or clearing within the easement will reduce flood levels and the frequency of overtopping of the private access road but the benefit will be very minor unless the capacity of the waterway opening under the access road is significantly increased.

5. Council will clear debris or fallen trees which are causing a blockage in main drainage infrastructure or on local roads. Residents wanting debris removed from their property are responsible for the organisation and payment for the works either through Council's household pick up service or a private company. If an area is declared a Natural Disaster area, government funding could be made available for clean up through the appointed Recovery Committee.

6. Council has an annual program for road inspection, maintenance and upgrading. Any road works necessary are prioritised within the limits of the funds available. Council does not maintain privately owned access roads e.g. the access road to Tall Timbers estate.

7. As an outcome of the 1997 Floodplain Management Plan, the house at 7 Mannings Road was raised as part of a development application for an extension to the existing dwelling. No other houses have been raised in the study area but would be considered on their merits if an application was made. There are no houses within the Tall Timbers estate with habitable floors below the 1% AEP flood level.

8. All houses in this area have on-site sewer management (OSSM) systems which are generally difficult to access for maintenance purposes, are situated close to a permanent water body and are easily affected by floods. As this estate is situated in an area of the floodplain, these types of systems would not be approved under current regulations.

   Council is currently preparing a Master Plan which will identify several priority 'investigation areas' which are not currently sewered but identified as requiring sewer service primarily due to OSSM problems. Should Tuggerah Street be identified as a priority area, the cost of connection would need to be borne by the residents at a rate negotiated with Council.

9. Gosford City Council, in conjunction with NSW SES, is in the process of preparing additional flood intelligence for the Gosford City Local Flood Plan for Tall Timbers Estate. The NSW SES will undertake a flood safety awareness program for the residents. Gosford City Council has installed a flood warning system. The construction of a safe refuge in the estate for flood events larger than the 1% AEP (sometimes referred to as vertical evacuation or shelter in place) would ensure that residents remain dry in events larger than the 1% AEP. However this measure does not eliminate the risk to life for the entire community.

10. Voluntary purchase of all houses in Tall Timbers estate is unlikely to receive funding from state or federal government authorities because the house floors are only inundated in events larger than the 1% AEP, consequently this option will have a very low benefit cost ratio.

11. Development controls will ensure that any future development are constructed in accordance with best practice but will not reduce the risk to life of the road access.

12. Gosford City and Wyong Shire Councils commissioned a new Flood Study of the Ourimbah Creek catchment, which includes the Cut Rock Creek catchment. The new flood study incorporates more technologically advanced computer modeling (use of a 2 dimensional hydraulic model) than used in the previous study together with the use of detailed up to date ground survey (ALS). The 2013 Ourimbah Creek Flood Study supersedes the 1994 Bangalow Creek and Cut Rock Creek Flood Study. A review of the Bangalow Creek and Cut Rock Creek Floodplain Management Study and Plan will be undertaken based on the updated flood modeling information as funding becomes available.

A glossary of flood related terms is provided in Appendix A.

1. INTRODUCTION

1.1. Background

The Bangalow Creek and Cut Rock Creek Floodplain Management Plan was completed in March 1997 (by Webb McKeown & Associates – now trading as WMAwater) and followed on from completion of the Management Study in 1996 and the Flood Study in 1994.

Gosford City Council's Floodplain Risk Management Committee Meeting of 22nd September 2011 recommended that a desktop review of the Cut Rock Creek Floodplain Management Plan (Area G2 – Tall Timbers estate) be undertaken as a matter of urgency due to the inability to access the estate during frequent storm events, with the outcomes to be reported as an addendum to the current Floodplain Management Plan.

Council adopted the recommendation and WMAwater was engaged in December 2011 to undertake the review. Figure 1 (taken from Google Maps) indicates the study area and Photo 1 shows the vehicular entrance to Tall Timbers estate from Tuggerah Street.

Figure 1: Study Area (courtesy Google maps)

The development in the area consists of 14 houses in the Tall Timbers estate, 6 on Mannings Road and the soccer club house and associated facilities on Pluim Park. All the houses in the Tall Timbers estate have similar floor levels at approximately 22.9 m AHD (lowest floor level).

Photo 1: Tall Timbers estate access road taken from Tuggerah Street (courtesy Google maps)

1.2. History of Flooding

1.2.1. 1994 Cut Rock Creek Flood Study

A comprehensive description of previous flooding is provided in the 1994 Bangalow Creek and Cut Rock Creek Flood Study and a summary is as follows:

- Approximately 20 floods have been qualitatively recorded in the Cut Rock Creek catchment since 1974. The largest of these were January 1978, October 1985, February 1990 and February 1992 which reached approximately 22.5 m AHD at Tall Timbers estate,
- The design flood levels (m AHD) taken from the 1994 Flood Study at the access road are:
    - 1% AEP = 23.0
    - 2% AEP = 22.8
    - 10% AEP = 22.4 and
    - Extreme Flood (approximation of the PMF) = 24.1.

A selection of historical flood photographs is provided below.

Photo 2: Debris under Tall Timbers estate access road

Photo 3: Flood downstream of Pacific Highway (2012)

Photo 4: Tall Timbers estate access road (alignment in red) in flood viewed from Mannings Road (1991)

1.2.2. Updated Flood Modelling (2013)

The crest level of the access road to the estate is 20.6 m AHD. According to residents the access road is inundated on average once every 1 or 2 years. In 2011 to 2012 it was inundated 3 times and impassable and in 2013 it was inundated 7 times. The duration of overtopping varies from 2 to more than 6 hours.

As a joint project between Gosford City and Wyong Shire Councils, a comprehensive Ourimbah Creek Catchment Flood Study Review, of which Cut Rock Creek is a tributary, was completed whilst preparing this document. Results from the modelling indicate a slight reduction in design flood levels to those given in the 1994 Flood Study. This is due partly to channel works constructed downstream since the 1994 Flood Study and improved modelling technology and survey detail available today. The results in Table 1 are taken from the 2013 Flood Study.

	AEP and Level in m AHD			
Location	**10%**	**2%**	**1%**	**PMF**
Tuggerah Street	23.67	23.86	23.81	24.59
Tall Timbers estate (access bridge)	21.93	22.29	22.47	23.81
Main North Railway (upstream)	21.78	22.18	22.38	23.69

Table 1: Design Flood Levels from the 2013 Ourimbah Creek Flood Study

1.2.3. Additional Flood Related Information

In the past gauges (termed Maximum Height Recorders or MHRs) recorded the peak level of floods along the creek system. There is an automatic water level recorder upstream of Tall Timbers estate in Tuggerah Street and records can be obtained from Manly Hydraulic Laboratory (MHL). In addition, there was a proposal as part of this investigation to install additional automatic water level recorders in the area with the potential to link them to some form of warning system. A water level recorder with real time data relay to MHL has now been installed at the private access bridge and SMS messages can be issued to residents advising

them that the bridge is about to be submerged.

Many residents have questioned why there has been so much flooding and overtopping of the Tall Timbers access road in the last few years. Some have thought it may have been due to the boulders placed downstream, increased sedimentation or some other man made or natural cause. The flooding may be due to increased rainfall as indicated by the annual rainfall graph (Figure 2) at Mt Elliot (located approximately 3 kms to the south east of Lisarow) which indicates significantly more rain from 2008 than in the period prior. However it should be noted that flooding occurs as a result of intense rain over a short period of time and annual rainfall statistics cannot reflect this.

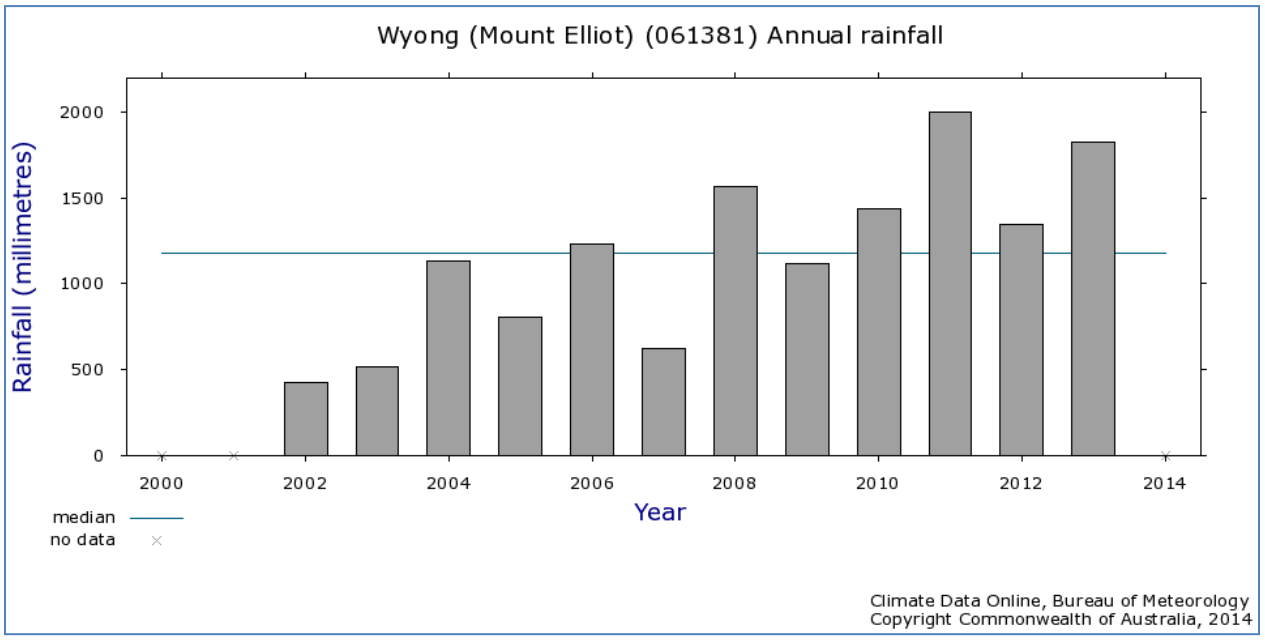


Figure 2: Mt Elliot Annual Rainfall

1.3. Scope of Work

The scope of work for WMAwater to undertake this review encompassed the following stages:

- review of all flood related information;
- prepare and mail out a newsletter and questionnaire (copy of this is provided in Appendix B**)** to all residents on Mannings Road and in the Tall Timbers estate (approximately 20); analyse results of the questionnaire (copy of this is provided in Appendix B);
- prepare and attend public workshops (held on 30th January 2012 at the Ourimbah-Lisarow RSL club and 17 June 2013 at Gosford City Council Administration Office);
- review all comments from the public, address issues, liaise with Council;
- review 1997 Bangalow Creek and Cut Rock Creek Floodplain Management Plan (Area G2) and prepare this report.

However, as investigations were undertaken to address issues raised by both the residents and Council officers, the scope of work was increased.

1.4. Public Workshops

1.4.1. January 2012

A PowerPoint presentation was provided by WMAwater at the public workshop. The purpose of the public workshop was to ensure that the residents were aware of:

- Who is responsible for what aspects of the estate e.g. ownership of the access bridge and who is responsible for the creek maintenance?
- The history surrounding the development;
- Historical flood events and flood extents;
- The current 1997 Floodplain Management Plan and works undertaken in accordance with that plan;
- Emergency management issues in relation to the current NSW Floodplain Development Manual;
- Potential flood events in relation to projected climate change;
- Potential management measures, namely:
    - Property modification;
    - Flood modification;
    - Emergency Response.

The desired outcomes from undertaking the workshop were to:

- Reduce misunderstandings regarding who is responsible for maintenance on and around the estate;
- Reduce misunderstandings regarding the intent of works that have been undertaken as recommended in the 1997 Floodplain Management Plan;
- Ensure residents were aware of the specific safety issues;
- Obtain information on what the residents may find acceptable as management measures.

1.4.2. Additional Workshop in June 2013

An additional public workshop was held on 17th June 2013 in the Council Committee Room. The purpose of this workshop was to present the Draft Addendum to the residents to bring them up to date and ensure that they understood, and generally were in agreement with, the outcomes from Council's investigations. These investigations have been undertaken by Council staff in response to issues raised at the previous January 2012 public meeting. A newsletter was issued to residents (a copy of this is provided in Appendix B**)**. A PowerPoint presentation was provided by WMAwater at the workshop and a copy of the Draft Addendum issued to the participants.

A number of additional issues were raised at this workshop which have been addressed both with the individual and / or incorporated into this document.

2. ASSESSMENT OF FLOODPLAIN MANAGEMENT ISSUES

The key issues and proposed outcomes following the public workshops and subsequent reviews by Council are summarised in the sections below.

2.1. Access to estate Frequently Cut by Floodwaters

The frequency and risk to life associated with flooding of the privately owned access road is the main issue of concern to the residents of the Tall Timbers estate. It is understood that the proposed subdivision development was approved in 1986. A plan of the proposed development (Figure 3) indicates a low level access road from Tuggerah Street with emergency access via the "railway maintenance track" in rare flood events.

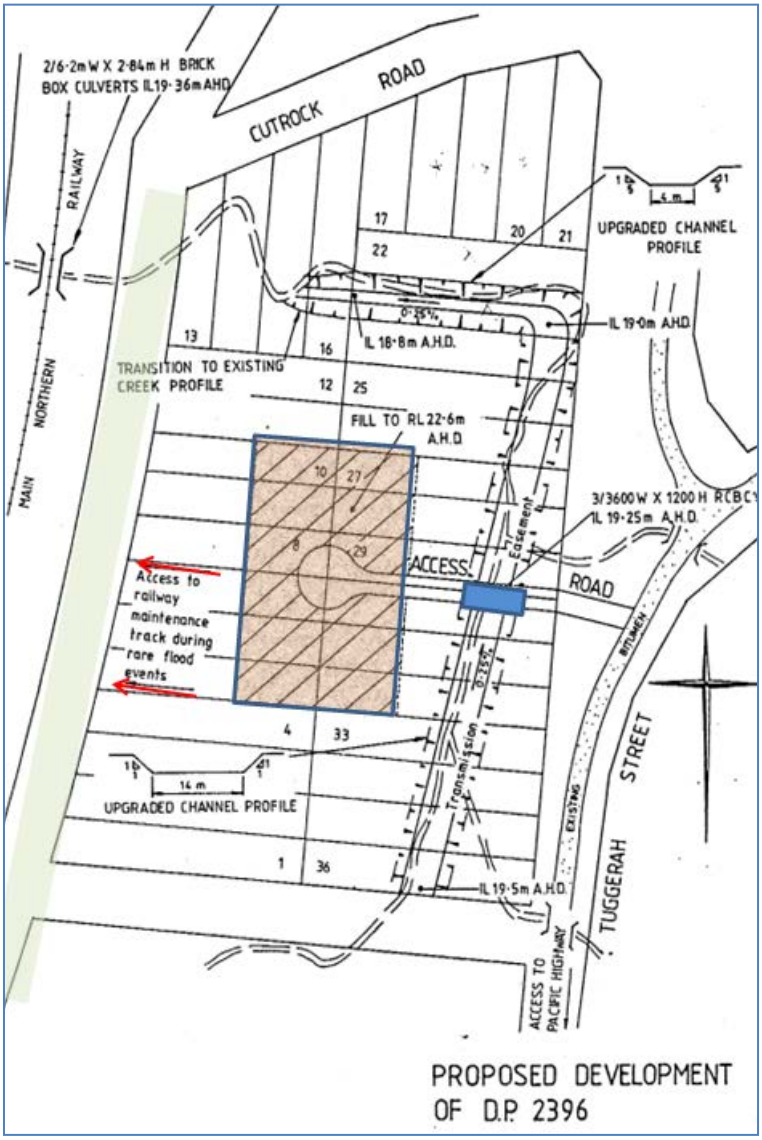


Figure 3: Development Plan circa 1986

For the 1980's design of the access bridge, the developer's hydraulic consultant estimated it would overtop in a storm event greater than the 20 year ARI (5% AEP) i.e. greater than approximately 20.6m AHD. This was deemed acceptable at that time. The modelling undertaken for the 1994 Flood Study of Cut Rock Creek indicated that the flood height for a 20

year ARI (5% AEP) was 22.6m AHD – a difference of approximately 2.0m AHD. The level of the deck of the access bridge is 20.6m AHD and is estimated to be overtopped in less than a 1 year ARI event (based on the 1994 Flood Study of Cut Rock Creek).

Figure 4 provides a typical cross section from west to east through the estate. ***Please note*** that the flood and ground levels are taken from the 2013 Ourimbah Creek Catchment Flood Study.

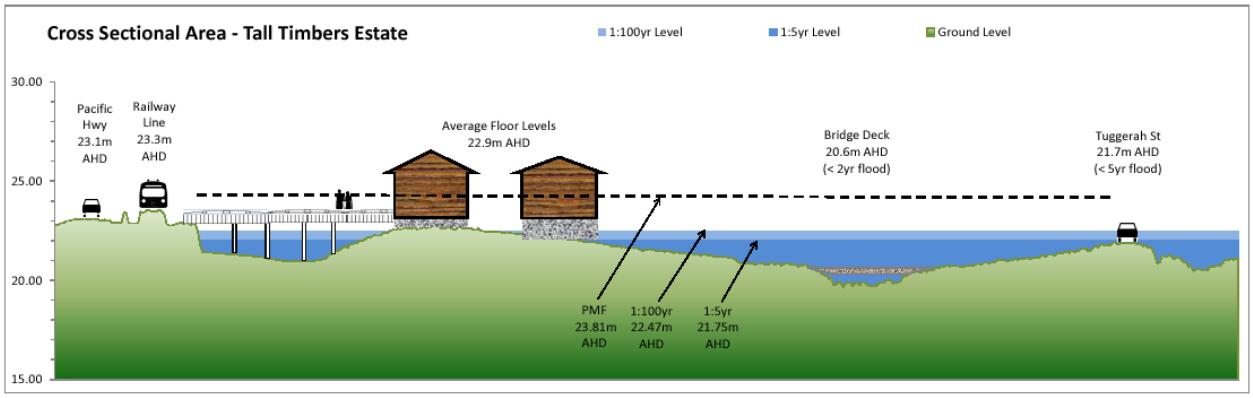


Figure 4: Cross Section of Tall Timbers estate showing flood heights

The outcome is:

a. The present level of access to Tall Timbers estate could be improved however, raising the access road would provide limited improvement in access as Tuggerah Street becomes impassable in approximately the 5 year ARI (20% AEP) flood event.

2.1.1. Raise Height of Private Access Road

The present frequency of overtopping of the access road (the only formal access to and from the estate) during floods is not in accordance with current best practice in floodplain management. The access road off Tuggerah Street is privately owned (this has been verified by searching of land titles) and therefore the responsibility of the owners of the estate to maintain, upgrade and replace when required.

The estimated cost to raise this road to equal the height of the adjoining public road i.e. Tuggerah Street is approximately $1M. Annual costs of approximately $25,000 would also be required to manage the overall life of the asset.

If Council were to consider taking ownership of the access road then it would set a precedent for all other privately owned access roads throughout its local government area. Council would also be required to purchase the land or acquire an easement over which the access road resides.

The cost to raise the section of the access road land within Council's road reserve to the level of Tuggerah Street is in the order of $40,000.

The outcomes are:

a. Should Council agree to take ownership of the access road it would set a precedent for other privately owned infrastructure and would need to procure an easement over the access road to ensure access for any future ongoing maintenance work.
b. Raising the access road would require a large number of culverts, or possibly a bridge structure, as well as raising the roadway adjoining either end of the structure. It is estimated that the cost to undertake this work is in the vicinity of $1M and $25,000 per annum to maintain the life of the asset.

2.1.2. Construct Pedestrian Bridge to Tuggerah Street

An alternative is to construct a pedestrian bridge capable of withstanding flood flows and potential frequent inundation. The cost for such a structure is estimated to be $840,000, however this would still only link to Tuggerah Street which is inundated in approximately the 5 year ARI (20% AEP) event

The outcome is:

a. Constructing an elevated pedestrian bridge would cost approximately $840,000.

2.1.3. Provide Pedestrian Access over Railway

The viability of the emergency access route indicated on the circa 1986 development plan (Figure 3) is unclear given that there is low lying land between the estate and the railway. No original approval from the relevant rail authority for use of their land for emergency access has been found. Regardless, this route is not available today as the railway is fenced to prevent access due to a fatality that occurred several years ago (it is understood that this is the reason why the overhead rail pedestrian footbridge near Teralba Street was constructed).

As a result there is no legal way of crossing the track. Construction of a pedestrian over bridge would cost in the order of $1.35M and the Rail Authority is reluctant to install more structures which will introduce an additional hazard to trains. It should be noted that an elevated path would also be required from the estate to any over bridge.

The residents of Tall Timbers estate are concerned that, with any new access to the estate from the west (railway side), there is the potential for increased loss of privacy or even higher risk of theft or similar. These concerns could be addressed with a gated access and/or additional street lighting.

The outcomes are:

a. There is no legitimate access across the railway.
b. Construction of a pedestrian over bridge would cost of the order of $1.35M.

2.1.4. Provide Emergency Access Route

NSW SES has indicated that if early evacuation is not possible or not undertaken, then the rescue of anyone trapped in Tall Timbers estate in an emergency during a flood could be

complex and resource intensive. The estate is surrounded by overhead power lines and densely forested on three sides with inadequate space for a helicopter evacuation. Also, the local roads would be inundated at the same time or very shortly after the access road, making evacuation by vehicle too dangerous.

Preliminary discussions have been held with Railcorp who has indicated that Council may be permitted to construct an elevated pedestrian/cycleway on railway owned land. Railcorp is also seeking permission to construct a bridge over Cut Rock Creek – from the western end of Mannings Road upstream of the present rail bridge - to gain vehicular access to their land for maintenance purposes. Railcorp indicated that they would erect another fence between the railway tracks and any proposed elevated pedestrian / cycleway.

A copy of the Concept Plan showing the proposed location and construction stages of the pedestrian / cycleway is shown as Figure 5. The total estimated cost of the elevated pathway is approximately $3.74M. The elevated pedestrian / cycleway should be capable of providing flood free access in a 100 year ARI (1% AEP) event to comply with current best practice for floodplain risk management. However, it will not provide safe access in a PMF event.

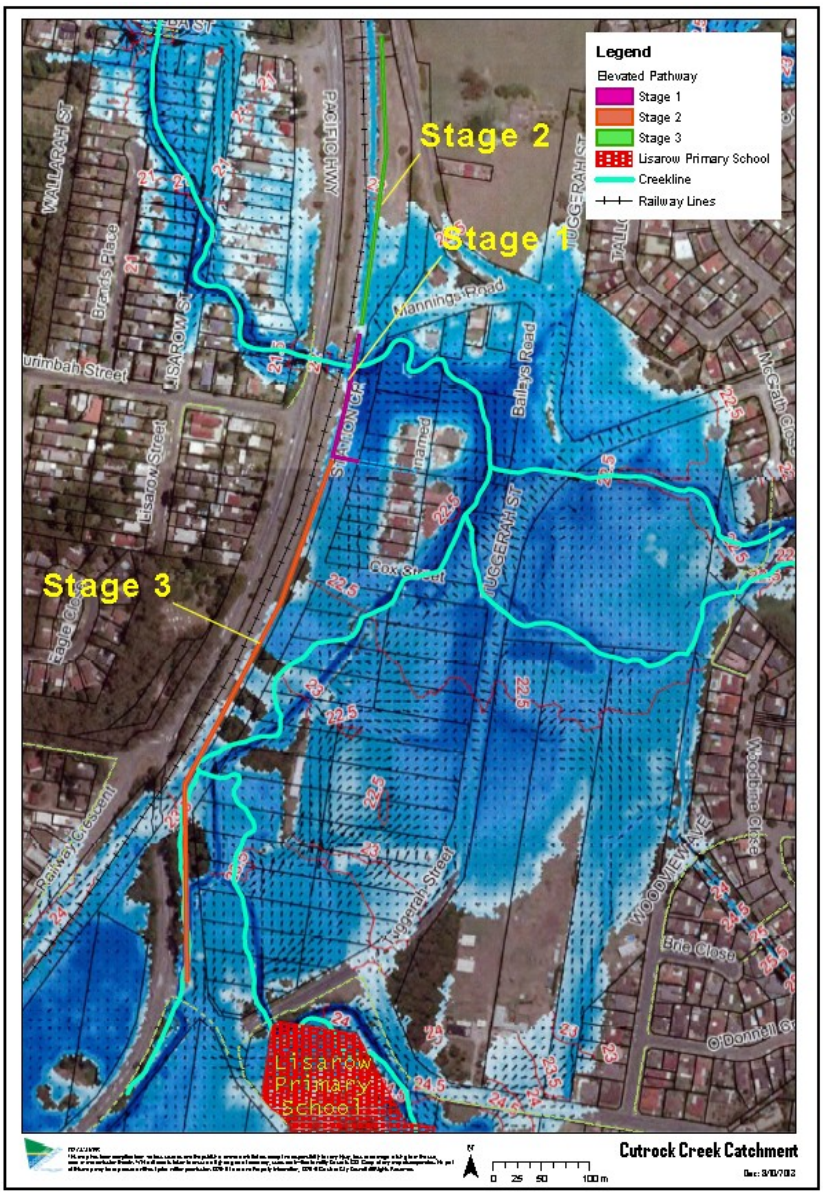


Figure 5: Proposed Pedestrian Emergency Access Route

It should be noted that this proposal is preliminary only and construction estimates could change. Further development of this proposal will depend on community acceptance, Council adoption of the concept design and Council's ability to attract funding towards each stage of the project. Prior to a detailed design being prepared, further negotiations will need to be undertaken with Railcorp, Wyong Council, Office of Environment and Heritage and also Roads and Maritime Services. Similar privacy and security risks as described in Section 2.1.3 are also relevant for this measure.

The proposal indicates that the pathway could be constructed in three stages with preliminary costs for each stage estimated as follows:

Stage 1: **Construction of an elevated pedestrian / cycleway providing access from Tall Timbers estate right-of-footway to the western end of Mannings Road.**
This would improve access and reduce the risk to life of residents on the estate. However, preliminary estimates indicate that Mannings Road is inundated in a 10 year ARI (10% AEP) storm event. Thus Stage 1 would only provide limited improvement however it would give residents flood free pedestrian access during the smaller more frequent storm events and additional time to evacuate to safety during larger events. The estimated cost of Stage 1 is $988,000.

Stage 2: Construction of elevated pedestrian / cycleway providing access from Mannings Road to railway pedestrian overbridge opposite Teralba Street.
As funding permits, the elevated pedestrian / cycleway (Figure 5 and Photo 5) could be further extended from Mannings Road to improve access to the railway pedestrian overbridge opposite Teralba Street. This would not only provide a safer pedestrian evacuation route to higher ground but would also improve the linkage between the various communities within both Wyong and Gosford Council areas. The estimated additional cost for this section is $594,000.

Stage 3: **Construction of elevated pedestrian / cycleway providing access from Tall Timbers estate right-of-footway to Macdonalds Road.**
The elevated pedestrian / cycleway could then be extended from the right-of-footway to link with Macdonalds Road. The access would provide a quicker, safer route to the local public school, Pluim Park gates and the Pacific Highway cycleway as well as to an area beyond the 100 year ARI (1% AEP) flood extent. This stage may require extensive bridging over the drainage paths at a cost of $2,158,000.

Photo 5: Example of an elevated pedestrian / cycleway

The outcomes are:

a. Construction of an elevated pathway is the only viable option that will provide safe access for the evacuation of residents from the Tall Timbers estate in floods up to the 100 year ARI (1% AEP) event.
b. There are potentially significant environmental issues with construction of the elevated pathway and these would need to be addressed with the respective authorities.

2.2. Pluim Park

The residents expressed the following concerns regarding Pluim Park:

- **Past or future works on Pluim Park have or might raise flood levels downstream.**
  All past developments since the mid 1990's have been assessed by Council to ensure that flood levels are not affected (this condition is the same for all potential developments on the floodplain). All future works at Pluim Park will be similarly assessed and thus it is concluded that this opinion is not supported by the available information.

- **Large amounts of top soil have been placed on the field which have reduced temporary floodplain storage (raising flood levels) and much of this has washed off and contributes to siltation at the culverts beneath the Tall Timbers estate access road.**
  Top dressing has occurred on the fields but the quantities involved have had an insignificant affect on the temporary floodplain storage capacity. During floods any exposed soil on the fields will be lost (as it will be for many other areas on the floodplain during a flood). There is no scientific documentation that confirms that the sand present beneath the Tall Timbers estate access road is from Pluim Park. During floods (Photo 6) there is likely to be significant amounts of erosion and subsequent mobilisation of sediment and vegetative matter transported downstream. All bridges, culverts and other structures have the potential to be affected; some may experience erosion of their abutments whilst others may have silt and debris deposited. Rivers are dynamic bodies and even during non-flood times siltation may occur, but generally to a lesser extent. Erosion and sedimentation are both natural phenomena and impossible to control, however both Pluim Park and Council will take steps to minimise this as far as is possible (for example reducing river velocities through appropriate vegetation planting, fencing and/or low walls).

Photo 6: Small flood across Pluim Park in 2011

- **There are future proposals for Pluim Park that will affect flooding downstream**.
  There are no submitted Development Applications for works within Pluim Park that will impact on flooding downstream. All development applications will be assessed (as in the past) to ensure that affectation on flooding downstream does not occur.

- **Works on Pluim Park have in the past not been approved or undertaken without consent**.
  All works having a possible impact on flooding have conformed to the required conditions according to Council records.

The outcomes are:

a. No past works on Pluim Park have had a significant impact on flood levels and none will be approved unless it can be demonstrated that no significant adverse impact will arise.
b. Erosion and sedimentation issues arising from developments on Pluim Park will be monitored and addressed if required.

2.3. Creek Maintenance

Cut Rock Creek is regularly inspected in accordance with Council's Area Maintenance Program and, where applicable, specific Plans of Management. This process allows routine maintenance actions to be prioritised on a network Council wide risk basis. Where the potential impacts are significant and life threatening, Council may carry out the removal of light vegetation and sediment deposits however, in general, these actions do not warrant regular maintenance intervention.

Council does not undertake creek maintenance on privately owned land where there is no easement in place. Council would only consider such works if a life threatening or similar situation arose. However, clearing has previously been undertaken by Council under the railway and highway bridge downstream of Tall Timbers estate due to complaints from residents regarding the deposition of rail ballast. Generally Council will only remove large trees, or similar, that have the potential to block culverts/bridges but do not remove light vegetation or remove deposited sediment.

Any resident undertaking works within the creek must be aware of environmental legislation requiring approval for such works from the Department of Primary Industries. Any resident undertaking illegal works without approval may be prosecuted. Council is also required to obtain similar approvals prior to undertaking any works within the creek.

If an area is declared a Natural Disaster area, government funding could be made available for clean up through the appointed Recovery Committee. Should residents wish to remove debris themselves (with approval), it is their responsibility to organise and pay for the work and the disposal of waste.

2.3.1. Works within the Creek

Residents have suggested that the creek be dredged or widened to increase the hydraulic capacity. These works would only have a limited benefit as the private access road provides the main constraint. In addition, dredging to below the invert of the culverts under the Pacific Highway would provide little benefit. Regardless, the dredging or widening of a creek is generally not supported in NSW on environmental and/or sustainability grounds if undertaken purely for flood mitigation purposes.

An approximate cost to undertake the creek dredging works for the full length of the easement as envisaged in Figure 3 is $122,000. These works will reduce flood levels and the frequency of overtopping of the private access road but the benefit will be very minor (less than 0.1m) unless the capacity of the waterway opening under the access road is significantly increased and bank and bed control works undertaken to stabilise and maintain the channel.

2.3.2. Upstream Bank and Bed Control Works

The worst area for bank erosion and sediment deposition has been occurring upstream of the access road causing the creek to become significantly narrower through 41A and 53 Tuggerah Street properties and the sediment deposited downstream reducing the capacity of the access bridge culverts. The portion of the creek downstream of the access road appears to have maintained its shape since it was formed by the developer.

At the 17th June 2013 workshop, residents requested that the portion of the creek upstream of the access road, and within the easement owned by Council, be rock lined with bed control to stabilise the banks and improve access for sediment removal.

An approximate cost to undertake the rock work for this portion of the easement as per the sketch in Figure 6 and Figure 7 is $567,000. These works will reduce flood levels and the frequency of overtopping of the private access road but the benefit will be very minor (less than 0.1m) unless the capacity of the waterway opening under the road is significantly increased.

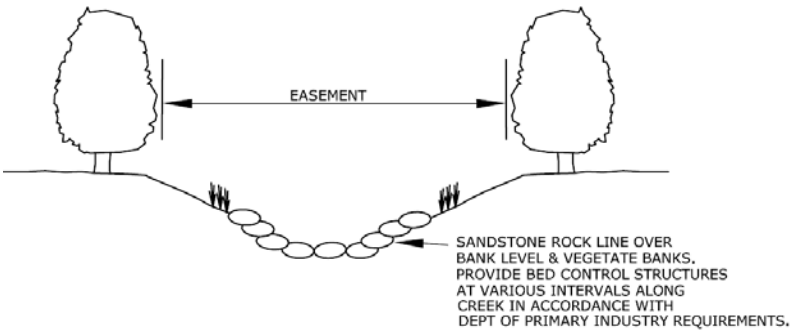


Figure 6: Proposed rock lining and bed control

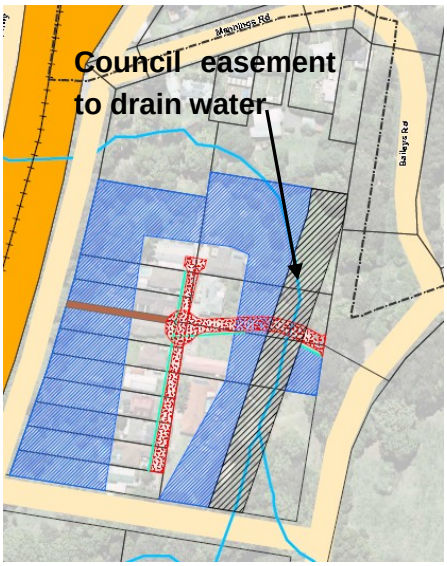


Figure 7: Site proposed for rocklining and bed control

2.3.3. Bank Erosion adjacent to Pluim Park

There is bank erosion and a large log and debris jam on land immediately upstream of 41 Tuggerah Street. The jam is causing flood water to flow around the debris and erode the soft sediment bank. Residents requested that this area be rock lined to stop the banks from eroding and the debris jam be removed.

A site meeting was held with the Catchment Management Authority (CMA) on 6th August 2013 and their verdict was that nothing should be removed (refer Appendix C). The land above the eroded bank is heavily vegetated with trees whose roots should hold the banks in place for some time to come, and the debris jam is acting as a collection point for other debris and sediment being transported from upstream.

The CMA advised that this is a natural process and undertaking any structural works would be unsatisfactory. The bank would continue to erode around the new rock work. Also, the debris jam was detaining floodwaters as well as slowing the migration of sediment from upstream of the estate. The CMA recommended that the erosion site and debris jam be regularly monitored over the next few years to see if the situation deteriorated however some of the smaller debris could be removed in conjunction with the CMA if desired.

The outcomes are:

a. Council will continue with its present level of involvement in creek management and monitor the situation with the assistance from the affected property owners.
b. Council will liaise with the owners of Pluim Park to construct measures to reduce erosion of topsoil.

2.4. Maintenance of Roads within Tall Timbers estate

Council has a regular road inspection, maintenance and upgrade program in place for public roadways throughout the Local Government Area. This program does not cover privately owned access roads e.g. the access road to Tall Timbers estate. The maintenance and upgrade of private access roads is the responsibility of the property owner/s.

The outcome is:

a. The maintenance and upgrade of private access roads is the responsibility of the property owner/s.

2.5. Boulders Placed in the Creek Downstream of the Pacific Highway

Channel works have been undertaken by Gosford City Council for the area between the Pacific Highway and Teralba Street (boundary with Wyong LGA). These works involved widening and clearing the channel of dense vegetation, purchase of a house, removal of private foot bridges across the creek, re-alignment and rock lining of the main channel, and revegetation. As a result of these works flood levels downstream of the Pacific Highway were reduced.

However it was acknowledged in the design of the works that these channel improvements would also lower flood levels upstream of the Pacific Highway. Whilst this is of benefit to residents of Tall Timbers estate, it meant that there is less temporary floodplain storage

upstream of the Pacific Highway and thus the peak flow would be increased to properties downstream of the Pacific Highway. This meant that flood levels immediately upstream of Teralba Street, and also within Wyong Shire, would be increased and so would adversely affect those residents.

Such an increase in level is not in accordance with Council's development control standards and for this reason boulders were included in the design to be placed immediately downstream of the Pacific Highway. The boulders would cause an obstruction to the flow of water during floods immediately downstream of the culverts and would raise flood levels back to near the pre-works levels in Tall Timbers estate. By using this design there would be no increase in flood level within Wyong LGA and also to properties located immediately upstream of Teralba Street.

Hydraulic modelling undertaken as part of the 2013 Ourimbah Creek Flood Study has indicated that, by removing the boulders and widening the channel (as discussed in Section 2.3.2) the flood levels would decrease upstream at Tall Timbers estate by 0.06m to 0.1m during the 1% AEP and by 0.07 to 0.15m during the 20% AEP.

The outcome is:

a. The boulders provide a satisfactory approach for maintaining the pre-works flood levels and flows both upstream and downstream of the Pacific Highway culverts.

2.6. Sewerage Leaching & Connection to Main Sewer Management System

Area G2 is not located within Council's defined sewer service area, nor have properties within the area contributed toward provision of or connection to Council's sewer reticulation system. Residents have complained of effluent overflows, smells and associated problems.

Approval for development of the land involved the applicant providing private individual On Site Sewerage Management (OSSM) systems. In 2009, Gosford City Council Waste Services staff undertook an audit of properties in Mannings Road and Tuggerah Street which encompassed the Tall Timbers estate. The audit revealed that due to the constraints of the sites, none of the properties would be able to comply with either the '*Environment and Health Protection Guidelines for On-site Sewage Management for Single Households'*, or the '*Australian Standard 1547:2012 On-site domestic wastewater management*'.

Council has identified this and another five un-serviced areas within the LGA for investigation for the provision of sewer under the Master Plan. Investigations may not be undertaken for several years as the Master Plan is proposed to address future service requirements to the year 2050.

It should be noted that Pluim Park was connected to Council's sewer reticulation system via a privately owned and operated pump and rising main at their expense.

An indicative cost to connect the houses to a sewer reticulation system is in the order of $800,000 to $1 million or $35,000 to $50,000 per household. The costs of connection would need to be negotiated between Council and the residents.

The outcome is:

a. Council will continue to investigate the potential for connection of the houses to Council's sewer reticulation system.

2.7. House Raising

As an outcome of the 1997 Management Plan, when 7 Mannings Road applied to undertake additions to the house, the floor level was raised to above the 100 year ARI (1% AEP) flood level. No other houses have applied to be raised but would be considered on their merits if an application was made and if grant funding could be obtained from State or Federal funds.

Slab on ground houses can be raised (as undertaken in Fairfield) but the cost is significantly higher than the estimated cost for raising a house on piers (say $60,000). However technically it can be undertaken. The main issues with raising houses are:

- only part of the cost is covered by grant funding (attached garages and pergolas are excluded);
- residents may resent having to climb steps;
- the house may be considered aesthetically less attractive;
- as this is voluntary residents may not agree to raising;
- raising may crack tiles or cause some other damage;
- residents may consider that it may be more economical to construct a new house at a higher level and thus would prefer the money for this purpose (this approach is not supported by the grant authorities);
- house raising will eliminate above floor damages (to the nominated flood level) but will not necessarily eliminate the risk to life as residents may still attempt to enter floodwaters to collect children from school, reach high ground or similar.

The outcomes are

a. Council will continue to assist with applications for house raising.
b. Increasing the density of development on Tall Timbers estate is not recommended.

2.8. Flood Emergency Management

2.8.1. SES and FloodSafe Education Programs

Gosford City Council has been working with NSW SES to include additional flood information for the Gosford City Local Flood Plan in regards to the Tall Timbers estate. NSW SES will also undertake a FloodSafe education program for all community members in Area G2 including the Lisarow Public School and Pluim Park.

According to the *Flood Emergency Response Planning Classification of Communities* guideline issued by the then Department of Environment and Climate Change in 2007, Tall Timbers estate is classified as a Low Flood Island. This means the area is isolated by floodwaters and will be completely covered in a flood event greater than the 100 year ARI (1% AEP).

The NSW SES provides FloodSafe kits and conduct flood awareness programs to make residents aware of the risk. In the event of an emergency during storms and/or floods, the NSW SES is available to assist if requested to do so by a resident or by other emergency services. The NSW SES also issue Evacuation Warnings and Orders if and when deemed necessary if "risk to life" is too great for residents to remain in situ and if there is sufficient warning time to evacuate residents from this area. Depending on the event, especially if it is flash flooding, there may not be sufficient warning time to consider early evacuation. If self-evacuation of the community is chosen to be achievable (which is obviously preferred) then it should be in a manner which is consistent with the NSW SES's principles for evacuation.

A flood warning system is not practical on a catchment wide basis but possibly an SMS flood warning message may provide some pre-warning for Area G2. This system has now been installed relatively economically but requires ongoing maintenance and continued flood awareness. The cost for this gauge was $9,250 with an annual cost of $2,500.

NSW SES does not have its own aircraft or pilots. However, from time to time, NSW SES work with these resources which are provided by other agencies or contractors and decisions relating to their use depends on a variety of factors including, but not limited to, weather and availability which can only be determined at the time of the incident. Decisions on flying and landing must be made by the pilot and the agency at the time of the emergency.

However in summary, none of the above measures would be an acceptable mitigation measure. The measures would reduce the risk but not eliminate the risk to life and is only a stop-gap measure until a more permanent measure is found.

The outcome is:

a. All available flood emergency awareness measures should be introduced however, they are only a stop-gap measure until a more permanent solution is found.

2.8.2. Vertical Evacuation or "Shelter in Place"

For some existing urban areas located in the floodplain there is no realistic opportunity to reduce flood levels, provide flood free access or purchase the land and buildings. The term vertical evacuation or "shelter in place" has been introduced to describe where persons relocate to higher levels of a building, usually on-site, and above the reach of flood waters. In some areas this is seen as the only means of providing a safe refuge. This requires the house to be constructed to a structural integrity much greater than for a normal house.

'Shelter in place' and 'vertical evacuation' are not equivalent to evacuation and therefore should not be considered as a primary means of dealing with the risk. The fact that people become trapped in their homes means that they have failed to evacuate safely from the flood affected area and therefore are considered 'trapped'. People who are trapped are still exposed to indirect flood risks relating to;

- their behaviour (drowning if they change their mind and attempt to leave after entrapment);
- their mobility (not being able to reach the highest part of the building);

- their personal safety (fire and accident); and
- their health (pre-existing condition or sudden onset e.g. heart attack).

Generally the SES do not support vertical evacuation as a means of approving a new development. However as a retro-fit solution for an existing problem, such as at Tall Timbers estate, the construction of such a structure (possibly as an addition to an existing building) would ensure that there is a secure flood free refuge for residents isolated in the estate during a flood greater than the 100 year ARI (1% AEP). However, vertical evacuation does not address the main concern which is frequent inundation of the private access road and consequent potential risk to life of crossing floodwaters.

The outcomes are:

a. Vertical evacuation could provide a safe refuge during a flood greater than the 100 year ARI (1% AEP).
b. Vertical evacuation does not address the risk of residents trapped in their homes and therefore exposed to potentially life threatening hazards during an emergency.
c. Vertical evacuation does not address the main concern of flood free access.

2.9. Voluntary Purchase

The homes at Tall Timbers estate are surrounded by floodwaters with vehicular access cut in frequent minor storm events. Even if the vehicular access is improved with a higher level crossing of the private road there is still no safe flood free access due to the relatively low level of Tuggerah Street. As these homes are all brick it would probably be more cost effective to rebuild the houses than raise them, but access would still be an issue.

As there are no viable means of improving the vehicle access, is voluntary purchase an appropriate measure for the existing 14 homes in the estate? This measure would cost approximately $5.6 million and up to $8 million if the 6 houses in Mannings Road are included. However it is difficult to justify this measure as the building floors in Tall Timbers estate are all above the 100 year ARI (1% AEP) flood level and thus the frequency of above floor damages is less than many other homes in NSW.

Furthermore, as the scheme is voluntary, it is likely that not all owners will wish to be purchased. Voluntary purchase schemes have been in place for many years (e.g. Maitland) with little success. Therefore a voluntary purchase scheme should be viewed in the long term.

Generally, houses are only placed in a voluntary purchase scheme when there is a significant risk to life and frequent above floor inundation. Whilst there is a significant risk to life if access is attempted during a flood, in events smaller than the 100 year ARI (1% AEP) event there is no risk if the resident stays in the house. If a house is placed in a scheme this may disadvantage the owner if a private sale is attempted, as disclosure of the scheme to a prospective purchaser may be required or even a note placed on the Section 149 certificate.

There are 14 houses on the Tall Timbers estate and 6 houses in Mannings Road serviced by privately owned individual on-site sewerage management systems which do not comply with current regulations (refer Section 2.6). If these properties are not connected to Council's sewer reticulation system in future they may need to be purchased.

The outcomes are:

a. Voluntary purchase is costly and may not be acceptable to all residents.
b. Houses should be connected to the sewer reticulation system to comply with current regulations and address ongoing health risks or potentially face voluntary purchase.
c. Voluntary purchase would eliminate the risk to life of the residents dwelling in the 14 houses on the Tall Timbers estate.

2.10. Household Flood Insurance

Household insurance has changed in the last 5 years and in particular since the January 2011 Brisbane River floods. As a consequence the majority (if not all) insurance companies offer flood insurance. Some companies require flood insurance to be taken out whilst others allow owners to opt out. A comparison of quotes can be obtained online and this suggests that flood insurance can add up to an additional $5,000 to the normal non flood household premium. However the rates vary markedly amongst the insurance companies and between houses in Tall Timbers estate although all have their floors at the same AHD level and thus similar likelihood of inundation.

For the majority of home owners with a mortgage, household insurance is compulsory, thus it is likely that for many owners their household insurance premium will have risen in the order of two or three times (even though there has been no above floor inundation of houses in the Tall Timbers estate). This situation is not unique to this area and there are many other examples in urban and rural areas of NSW.

Due to the flood hazard in this area, insurance companies in the future may not be able to provide affordable insurance or may choose to not provide any insurance.

The outcomes are:

a. Flood insurance for houses is now available from many companies.
b. Premiums may increase if flood insurance is included.
c. Flood insurance may be compulsory for homes with a mortgage.
d. Flood insurance does not address the main concern of flood free access.

2.11. Mitigation Dams

Residents have asked if retarding basins could be constructed in the upper catchment to temporarily store flood waters and so reduce flood levels at Tall Timbers estate. This suggestion is not feasible for a number of reasons, the main one being that the catchment area above Tall Timbers estate is over 6 km^2 and a small dam would not provide any significant benefit. There is no suitable space for such a large structure and the cost would be of the order of $15 million. In addition there would be significant environmental issues (loss of vegetation / habitat) to resolve. Construction of several small basins is not viable due to the lack of available sites.

A retarding basin was recently completed in Chamberlain Road to retard frequent minor flows from new development upstream of Pluim Park and Tall Timbers estate.

The outcome is:

a. Flood mitigation dams or basins upstream are not possible.

2.12. Development Controls for Mannings Road & Tuggerah Street

Increasing the density of development in Tuggerah Street and Mannings Road is not recommended. Development controls will ensure that there are limitations to expansion of this area in future. However controls will not reduce the existing risk of damage to existing properties and to life during a flood event. Increasing the density in this area will also potentially increase the health risks associated with the on-site sewer management systems, and the number of people put at risk placing a greater demand for the SES to rescue residents during a flood event.

The outcomes are:

a. No further intensification of development in Mannings Road and Tuggerah Street.
b. Increased flood related development controls will not reduce damages to existing development, health issues related to the OSSMS or risk to life.

2.13. Do Nothing

The do nothing option will mean that residents will continue to be faced with a significant risk to life during times of flood and in time will have their floors inundated when a large flood occurs.

With the potential for future changes in climatic conditions, there is also the potential for more frequent inundation of the 20 privately owned individual on-site sewerage management systems as well as the continuation of effluent leaching from those systems into the creek. This would increase the risk to both the health of the residents and the surrounding environment.

3. SUMMARY OF MANAGEMENT MEASURES CONSIDERED

The measures were separated into short, medium and long term. It should be noted that these measures will be reviewed in any future Floodplain Risk Management Study and Plan when resources and funding becomes available.

POSSIBLE MEASURE	COST	RESPONSIBILITY	BENEFIT	TIMEFRAME
2.1.1 *Raise Private Access Road to connect to Tuggerah Street*				
Raise private access road to the level of Tuggerah Street	$1.07m + $25,000 per annum ongoing maintenance and replacement cost	Residents	Provide flood free vehicular access up to < 20% AEP.	Long term
2.1.2 *Raise Private Access Road to connect to Tuggerah Street*				
Construct pedestrian bridge adjacent to access road	$840,000	Residents	Provide flood free pedestrian access up to < 20%+ AEP.	Long term
2.1.3 *Pedestrian Access over Railway*				
Construct pedestrian bridge over railway immediately adjacent to estate	$1.35m	Rail Authority / Local Govt	Provide flood free access to Pacific Highway.	Long term
2.1.4 *Emergency Pedestrian Access Route*				
Stage 1 **Tall Timbers estate to Mannings Road - would significantly improve access and lessen the risk to life for the residents of Tall Timbers estate in a 1% AEP event.**	$988,000	Rail Authority / Local Govt	Provide pedestrian access to Mannings Road up to 1% AEP	Long term
Stage 2 **- Mannings Road to pedestrian overbridge opposite Teralba Street.**	$594,000	Rail Authority / Local Govt	Provide pedestrian access up to 1% AEP.	Long term
Stage 3 **Tall Timbers to Macdonalds Road - would provide quicker, safer route to the Lisarow Public school, Pluim Park and Pacific Highway in the 1% AEP event.**	$2.16m	Rail Authority / Local Govt	Provide pedestrian access up to 1% AEP.	Long term
2.2 Pluim Park				
Minimise sedimentation transfer from Pluim Park through vegetation growth and/or additional low wall and fencing	$20,000	Central Coast Football	Reduce incidence of sedimentation of creek	Short term
2.3 Creek Maintenance				
2.3.1 Remove sediment build-up from easement	$122,000 + $50,000 per annum	Local Govt	Marginally lower flood levels	Short term
2.3.2 Widen channel and stabilise banks for 200 lineal metres of easement	$566,600	Local Govt	Reduce bank erosion and slumping and marginally lower flood levels	Long Term
2.3.3 Monitor log jam, slumping and sediment migration adjacent to Pluim Park		Local Govt / benefiting residents & owners	No impact on flood levels	Short Term
2.4 Maintenance of Private Roads				
Council does not maintain private roads		Residents		n/a

POSSIBLE MEASURE	COST	RESPONSIBILITY	BENEFIT	TIMEFRAME
2.5 Boulders Downstream of Highway				
Council to maintain present approach		Local Govt		n/a
2.6 *Sewer Management System*				
Extend sewer system to 14 properties in Tuggerah Street and 6 properties in Mannings Road	$35,000- $50,000 per property	Residents / Local Govt	Ensure properties comply with current sewage standards and eliminate health risk	Long term
2.7 *House Raising*				
Raise house floor levels to above the PMF flood level. *NB All floor levels are above the 1% AEP flood level according to the 2013 Ourimbah Creek Study*	$60,000 for non brick and $100,000 for brick	Local & State Govt grant & residents	Will reduce flood damages but not the risk to life with access	As required by residents
2.8 Emergency Management				
2.8.1 Provides all available emergency management measures	$9,250 + $2,500 ongoing annual maintenance cost	SES / local Govt	Automatic flood warning system for SES and residents	Short term
2.8.2 Provide structure suitable for vertical evacuation	Will depend on type of structure	Residents	Reduce risk to life in a greater than 1% AEP event	Long term
2.9 Voluntary Purchase				
14 properties in Tall Timbers estate and 6 in Mannings Road	$5.6m - $8m	Local & State Govt	Will eliminate the flood hazard, risk to life and health and environmental issues	Long term
2.12 Development Controls				
Introduce development controls to reduce damages and risk to life in the modification of existing houses	Paid for by owner	Local Govt to implement	Reduces damages for new development and risk to life	n/a
2.13 Do Nothing				
Residents continue to face a significant flood risk – risk to life and damage to property			None	n/a

4. RANKING OF MANAGEMENT MEASURES

4.1. Management Measures Scoring Matrix

The management measures being considered were assessed using the matrix shown in Table 2 which is based on the guidelines in Appendix 10 of the NSW Government Floodplain Development Manual 2005.

This scoring system looks at social, environmental and economic issues. It should be noted that all measures will be reviewed in any future Floodplain Risk Management Study and Plan when resources and funding becomes available.

It should also be noted that, with solely a benefit / cost analysis all the Benefit / Cost ratios for works and voluntary purchase are less than 1 i.e. very little tangible economic benefit compared to the high cost for the various measures.

	-3	-2	-1	0	1	2	3
Impact on Flood Behaviour	>100mm increase	50mm increase	<50mm increase	neutral	<50mm decrease	50 to 100mm decrease	>100mm decrease
No. of Properties Benefiting	>5 adversely affected	2-5 adversely affected	<2 adversely affected	none	<2	2 to 5	>5
Technical Feasibility	major issue	moderate issue	minor issue	neutral	moderately straight forward	straight forward	no issues
Community Acceptance	majority against	most against	some against	neutral	minor	most	majority
Economic Merits	major disbenefit	moderate disbenefit	minor disbenefit	neutral	low	medium	high
Financial Feasibility	major disbenefit	moderate disbenefit	minor disbenefit	neutral	low	medium	high
Environmental & Ecological Benefits	major disbenefit	moderate disbenefit	minor disbenefit	neutral	low	medium	high
Impact on SES	major disbenefit	moderate disbenefit	minor disbenefit	neutral	minor benefit	moderate benefit	major benefit
Political / Admin Issues	major negative	moderate negative	minor negative	neutral	few	very few	none
Services & Infrastructure	major disbenefit	moderate disbenefit	minor disbenefit	neutral	minor benefit	moderate benefit	major benefit
Risk to Life	major increase	moderate increase	minor increase	neutral	minor benefit	moderate benefit	major benefit

Table 2: Management Measures Matrix Scoring System

4.2. Management Measures Assessment

The results of scoring each measure according to the values in Table 2 is shown in Table 3.

Report Ref	Option	Impact on Flood Behaviour	Properties Benefiting	Technical Feasibility	Community Acceptance	Economic Merits	Financial Feasibility	Environmental & Ecological Benefits	Impact on SES	Political / Admin Issues	Risk to Life	TOTAL
2.1.1	Raise height of private access road	-1	3	2	3	0	-2	0	-1	-2	-2	0
2.1.2	Construct pedestrian bridge to Tuggerah Street	-1	3	2	3	0	-2	0	-1	-2	-2	0
2.1.3	Provide pedestrian access over railway line	0	3	-2	2	-1	-3	0	2	-3	3	1
2.1.4	Provide emergency pedestrian access above the 1% AEP	-1	3	1	0	-1	2	0	3	-1	3	9
2.2	Sediment controls at Pluim Park	1	0	2	3	0	2	1	0	3	0	12
2.3.1	Creek dredging	0	0	2	3	-2	2	1	0	2	1	9
2.3.2	Bank and bed control	0	0	2	3	-2	1	1	1	-1	1	6
2.3.3	Bank erosion adjacent to Pluim Park & log jam	0	0	0	2	0	0	1	0	-1	0	2
2.4	Maintenance of roads on Tall Timbers estate	0	3	2	3	0	-2	0	-1	-3	0	2
2.6	Connect 20 properties to the sewer reticulation system	0	3	-3	0	-3	-3	3	0	-3	3	-3
2.7	House Raising	0	0	-2	0	0	0	0	0	1	0	-1
2.8.1	Flood warning and preparedness	0	3	3	3	-1	3	0	3	2	3	19
2.8.2	Shelter in place	0	1	-1	2	0	0	0	1	1	2	6
2.9	Voluntary purchase	0	3	-2	0	0	2	3	3	-2	3	10
2.11	Mitigation dams	0	0	-2	1	0	-2	0	0	-3	0	-6
2.12	Development controls	0	3	3	1	0	2	1	1	3	0	14

Table 3: Management Measures Assessment

5. DETAILED COSTING OF MANAGEMENT MEASURES CONSIDERED

5.1. Raise Private Access Road

POSSIBLE MEASURE	Item	Cost
Raise private access road to the level of Tuggerah Street Construction - Concrete beam and decking on concrete piers 5.0m wide carriageway (*similar construction to Mills Creek bridge*) Decking and piers required to be able to withstand flood flows with additional forces from floating debris. Estimate provided without geotechnical information or structural design. Costs may escalate due to suspected poor foundations. (*Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations*)	Design Geotechnical Foundations Piers and abutments Deck Guard Rail Pavement **Total**	20,000 20,000 400,000 120,000 400,000 70,000 40,000 **1,007,000**

5.2. Construct Pedestrian Bridge

POSSIBLE MEASURE	Item	Cost
Construct Pedestrian Bridge adjacent to private access road Pedestrian Bridge to be construction to the same level as Tuggerah Street. Construction - Concrete pier foundations, 3.0m wide concrete decking with galvanised steel handrails Decking and piers required to be able to withstand flood flows with additional forces from floating debris. Estimate provided without geotechnical information or structural design. Costs may escalate due to suspected poor foundations. (*Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations*)	Design Geotechnical Foundations Piers and abutments Deck **Total**	20,000 20,000 200,000 50,000 550,000 **840,000**

5.3. Construct pedestrian bridge over railway

POSSIBLE MEASURE	Item	Cost
Pedestrian Bridge to be constructed over Great Northern Railway Construction - Concrete beam and decking on concrete piers 3.0m wide with galvanised steel handrails from estate to overhead bridge Decking and piers required to be able to withstand flood flows with additional forces from floating debris Estimate of cost provided by Rail Authority for construction of a bridge over the railway line Estimate provided without geotechnical information or structural design. Costs may escalate due to suspected poor foundations. (*Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations*) **NB Although cost provided, rail authority is reluctant to install additional bridges over lines due to increasing potential hazards for trains**	Deck Railway Overbridge **Total**	550,000 800,000 **1,350,000**

5.4. Emergency Access Route

POSSIBLE MEASURE	Item	Cost
<u>Stage 1</u> Tall Timbers estate to Mannings Road - would significantly improve and lessen the risk to life for the residents of Tall Timbers estate.		
Concrete slab on ground 3.0m wide (53m @ $266/lm)	Design	20,000
Elevated boardwalk 3.0m wide for entire length (149m @ $1,800/lm)	Geotechnical	40,000
Elevated boardwalk supporting structure 1-2m high (55m @ $1,800)	Boardwalk	268,200
Elevated boardwalk supporting structure 2-3m high (74m @ $2,100)	Bridge and Abutments	355,000
Bridge spanning over Cut Rock Creek (17m span)	Slab on ground	14,098
Construction - Concrete pier foundations, concrete decking with galvanised steel handrails 3.0m wide	Supporting Structure	290,550
Decking and piers required to be able to withstand flood flows with additional forces from floating debris.		
Estimate provided without geotechnical information or structural design. Costs may escalate due to suspected poor foundations. (*Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations*)		
(There has been no indication from Rail Authority that permission to use their land will be approved, therefore it cannot be used as an assumption)	**Total**	**987,848**

POSSIBLE MEASURE	Item	Cost
<u>Stage 2</u> - Mannings Road to pedestrian over bridge opposite Teralba Street – would connect residents to assistance outside the floodplain		
Clearing and disposal of vegetation	Design	20,000
Elevated boardwalk 3.0m wide for 134m @ $1,800/lm	Clearing	20,000
Elevated boardwalk supporting structure (134m @ $1,800)	Geotechnical	20,000
Concrete slab on ground 3.0m wide for (193m @ $266/lm)	Boardwalk	241,200
Construction - Concrete pier foundations, concrete decking with galvanised steel handrails	Supporting Structure	241,200
Decking and piers required to be able to withstand flood conditions with floating debris.	Slab on ground	51,338
Estimate provided without geotechnical information or structural design. Costs may escalate due to suspected poor foundations. (*Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations*)		
(There has been no indication from Rail Authority that permission to use their land will be approved, therefore it cannot be used as an assumption)	**Total**	**593,738**

POSSIBLE MEASURE	Item	Cost
<u>Stage 3</u> Tall Timbers estate to Macdonalds Road - would provide quicker, safer route to the school, Pluim Park and Pacific Highway in a 1% AEP event. Elevated boardwalk 3.0m wide for entire length (520m @ $1,800/lm) Elevated boardwalk supporting structure (520m @ $2,100) Construction - Concrete pier foundations, concrete decking with galvanised steel handrails Decking and piers required to be able to withstand flood conditions with floating debris. Estimate provided without geotechnical information or structural design. Costs may escalate due to suspected poor foundations. (*Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations*) **(Unclear whether this option is possible due to ecologically endangered vegetation)**	Design Geotechnical Clearing Boardwalk Supporting Structure **Total**	40,000 40,000 50,000 936,000 1,092,000 **2,158,000**

5.5. Creek Maintenance - Sediment Removal

POSSIBLE MEASURE	Item	Cost
Remove sediment build-up from easement. Removal of sediment and weed growth **(Ongoing maintenance costs of approximately $50,000 per annum)**	Govt Application Erosion & sediment control Dredge & disposal Site restoration **Total**	 25,000 77,000 20,000 **122,000**

5.6. Upstream Bank and Bed Control Works

POSSIBLE MEASURE	Item	Cost
Widen channel and stabilize banks in Council easement. Widen and rock line 200 lineal metres of creek channel Construction - Increase depth and width of creek and line with rip-rap rock base and toe of batter Excavation and disposal costs may vary up or down due to not being any geotechnical information. Rail line crossing at Cut Rock Creek required extensive footings to reach good foundations,	Govt Application Geotechnical Erosion & sediment control & Dewatering Excavation and disposal Rip-rap and Supply & lay batter Site restoration **Total**	 20,000 31,600 172,000 53,000 270,000 20,000 **566,600**

6. RECOMMENDED MANAGEMENT MEASURES

The following are a list of the recommended measures based on the risk and socio-economic results. They have also been further assessed for short, medium and long term timeframes.
It should be noted that all measures will be reviewed in any future Floodplain Risk Management Study and Plan when resources and funding becomes available.

It should also be noted that the estimated costs may rise due to having geotechnical or structural details when undertaking the estimates.

RECOMMENDED MEASURE	COST	RESPONSIBILITY	BENEFIT	TOTAL SCORE IN MATRIX	TIMEFRAME
2.9 Voluntary Purchase					
14 properties in Tall Timbers estate and 6 in Mannings Road	$5.6million to $8 million	Local and State Govt	Will eliminate the sewerage and flood risks	10	Long term
2.1.3 *Emergency Pedestrian Access Route*					
Stage 1 **Tall Timbers to Mannings Road**	$988,000	Local Govt	Provide up to 20% AEP pedestrian access	9	Medium term
Stage 2 **- Mannings Road to pedestrian overbridge opposite Teralba Street.**	$594,000	Local Govt	Provide up to 1% AEP pedestrian access	9	Medium term
Stage 3 **Tall Timbers to McDonalds Road**	$2,158,000	Local Govt	Provide up to 1% AEP pedestrian access.	9	Long term
2.2 Pluim Park					
Minimise sedimentation from Pluim Park	$20,000	Central Coast Football	Reduce sedimentation	12	Short term
2.3 Creek Maintenance					
2.3.1 Remove sediment build-up from easement	$50,000 per annum	Local Govt	Marginally lower flood levels	9	Short term
2.3.3 Monitor log jam, slumping and sediment migration	$2,500 per annum	Local Govt / benefiting residents	No impact on flood levels	2	Short Term
2.8 Emergency Management					
2.8.1 Provide emergency management measures and install automatic flood warning system	$9,250 + $2,500 per annum	SES / Local Govt	Residents prepared for floods	19	Short term
2.12 Development Controls					
2.12 Controls to restrict type of development on existing houses	Paid for by owner	Local Govt	Reduces damages and risk to life during floods	14	Short term

7. SPECIFIC DEVELOPMENT CONTROLS

7.1. For Tall Timbers estate and Mannings Road

- no further subdivision permitted;
- no further intensification of development which results in additional load on OSSMS or increase in the number of bedrooms;
- no filling of the floodplain beyond the building envelope;
- double storey houses are permitted if the 2nd floor to be used for “shelter in place”;
- alterations and additions permitted on a one off basis within the set building envelop and shall not exceed 20% of the current building value. A building valuation report is to be submitted with the development application confirming compliance with this criterion. **This condition applies to Tall Timbers estate properties only;**
- alterations and additions are encouraged to provide “shelter in place” and which are able to withstand the forces of water and debris loading in flood events up to the PMF;
- any alterations or additions to take into account flooding issues (i.e. electrical boxes and air conditioners etc. above the Flood Planning Level and all construction below the Flood Planning Level to consist of flood proof building materials);
- the Flood Planning Level be maintained at the 1% AEP (100 year ARI) flood level plus a 0.5m freeboard;
- renovations, landscaping, swimming pools, minor extensions to buildings, fences and other home improvements must not impede the passage of flood flows so as to adversely affect adjoining properties.

7.2. For Pluim Park

- development controls for future development of Pluim Park must be in accordance with the guidelines in Appendix C of the Bangalow Creek and Cut Rock Creek Floodplain Management Plan (1997).

7.3. General

- all new buildings, development or filling on the floodplain must be in strict accordance with Council’s Guidelines outlined in the Development Strategies – Local (refer to Bangalow Creek & Cut Rock Creek Floodplain Management Plan 1997 for details).

APPENDIX A: GLOSSARY

Taken from the Floodplain Development Manual (April 2005 edition)

acid sulfate soils	Are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m^3/s or larger event occurring in any one year (see ARI).
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average Annual Damage (AAD)	Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
Average Recurrence Interval (ARI)	The long term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
caravan and moveable home parks	Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.
catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
consent authority	The Council, Government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the Council, however legislation or an EPI may specify a Minister or public authority (other than a Council), or the Director General of (old) DIPNR, as having the function to determine an application.
development	Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act). **infill development:** refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as Flood Planning Levels may be imposed on infill development. **new development:** refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power. **redevelopment:** refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.
disaster plan (DISPLAN)	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.

discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood awareness	Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.
flood education	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves an their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).
flood mitigation standard	The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.
floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.

flood planning area	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the flood liable land concept in the 1986 Manual.
Flood Planning Levels (FPLs)	FPLs are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the standard flood event in the 1986 manual.
flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
flood readiness	Flood readiness is an ability to react within the effective warning time.
flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. **existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain. **future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain. **continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.
freeboard	Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.
habitable room	**in a residential situation:** a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. **in an industrial or commercial situation:** an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
hazard	A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Manual.
hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.

hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
local drainage	Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.
mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
major drainage	Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves: • the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or • water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or • major overland flow paths through developed areas outside of defined drainage reserves; and/or • the potential to affect a number of buildings along the major flow path.
mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
merit approach	The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains. The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.
minor, moderate and major flooding	Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood: **minor flooding:** causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded. **moderate flooding:** low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered. **major flooding:** appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	Measures that modify either the flood, the property or the response to flooding.

	Examples are indicated in Table 2.1 with further discussion in the Manual.
peak discharge	The maximum discharge occurring during a flood event.
Probable Maximum Flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
probability	A statistical measure of the expected chance of flooding (see AEP).
risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	The amount of rainfall which actually ends up as streaFPLow, also known as rainfall excess.
stage	Equivalent to water level. Both are measured with reference to a specified datum.
stage hydrograph	A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	A plan prepared by a registered surveyor.
water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	The horizontal distance in the direction of wind over which wind waves are generated.

Appendix B

Cut Rock Creek Catchment – Area G2
Pluim Park/Tall Timbers Estate/Mannings Road
Review of Floodplain Risk Management Plan
— Community Information Newsletter January 2012

Introduction

Under the NSW Government's Flood Prone Land Policy, management of flood prone land is primarily the responsibility of councils.

Gosford City Council has appointed WMAwater (formerly Webb McKeown & Associates) to carry out a Review of the 1997 Bangalow and Cut Rock Creek Floodplain Risk Management Plan for **Area G2: Pluim Park/Tall Timbers Estate/Mannings Road**.

The Floodplain Risk Management Plan provides a basis for sound floodplain management planning for the area, which recognises the demands for development and change, the need for good urban and environmental outcomes, and the social and economic benefits of reducing flood damage.

FIGURE 1: Study Area

The Bangalow and Cut Rock Creek Floodplain Risk Management Plan, completed in 1997, was the first to be funded under the NSW Government's Floodplain Management Program within the catchment. This study determined design flood levels (i.e. the 100 year and other average recurrence interval events) and flows throughout the catchment and recommended measures to manage the flood problem.

The Study Area

Cut Rock Creek has a catchment area of approximately 10 km² and is a major tributary of Bangalow Creek which enters Ourimbah Creek and eventually Tuggerah Lakes.

The Study area comprises the floodplain from Pluim Park downstream to the Sydney-Newcastle railway line and includes the two residential areas of Tall Timbers Estate and along Mannings Road.

The main flooding issue from the Tall Timbers Estate is the inundation of the privately owned vehicle access bridge from Tuggerah Street. However other issues include:

- The impact of upstream development on water quantity and quality,
- The placement of a series of rocks in the channel immediately downstream of the highway,
- Erosion of the channel,
- Frequent nuisance flooding,
- Maintenance of the channel (removal of vegetative and other debris),

PHOTOGRAPH 1: View to Tall Timbers Estate from Tuggerah Street

Floodplain Management Program

The first step in the process (Diagram 1) is data collection and the preparation of the Flood Study (completed in 1994).

DIAGRAM 1: The Floodplain Risk Management Process

The second step is the preparation of a Floodplain Risk Management Study (FRMS) that identifies a range of floodplain management measures to address the problems and areas of concern (completed in 1997).

The third stage involves preparation of a Plan that documents how the proposed measures identified in the FRMS are to be implemented in terms of resources and timing (completed in 1997). The final stage of the process is the allocation of funds and undertaking of the works (as occurred downstream of the highway).

The Floodplain Risk Management Plan

The objectives of the Floodplain Risk Management Plan are to:

- manage flooding as an integral part of the planning and development process;
- systematically identify and address flooding problems;
- prepare a schedule of strategies to manage the existing flood problem and reduce future flood damage;
- implement a unified approach;
- ensure sustainable development principles are achieved;
- maintain and enhance the capacity and quality of the drainage system; and
- gain community participation in the decision making process.

Why is this Review being Undertaken?

This Review is being undertaken as part of the above NSW Government Floodplain Management Program to ensure that the past recommended management measures are still appropriate or new measures should now be considered.

PHOTOGRAPH 2: Houses along Mannings Road

The Community Consultation Program

Community involvement is important at all stages of the Floodplain Risk Management Process. Residents' local knowledge of the catchment and personal experiences of previous flooding provide an invaluable source of data to define the nature and extent of flooding.

It is important to get community input and feedback to ensure proposed measures meet the needs and expectations of the local community. The importance of community involvement is recognised through the implementation of a community consultation program that is an integral part of each stage of the Floodplain Risk Management Process.

How Do I Get Involved?

Community input into the Review of the Floodplain Risk Management Plan for this area is essential and a Public Meeting will be held at: Ourimbah-Lisarow RSL Club on Monday 30 January 2012. RSVP Sue Stanford before Monday 23 January for catering purposes.

Please return the attached Questionnaire in the Reply Paid envelope. To seek clarification on any issue, please contact us.

Sue Stanford
Flooding and Drainage Planning Engineer | Integrated Planning
Gosford City Council
PO Box 21 Gosford NSW 2250
Phone: 4325 8818 Fax: 4323 2528
Email: **sue.stanford@gosford.nsw.gov.au**

or

Richard Dewar
Director **WMAwater**
Level 2, 160 Clarence Street
Sydney, NSW, 2000
Phone: 9299 2855 Fax: 9262 6208
Email: **dewar@wmawater.com.au**

COMMUNITY QUESTIONNAIRE

Cut Rock Creek Catchment – Area G2
Pluim Park/Tall Timbers Estate/Mannings Road
Review of Floodplain Risk Management Plan

INTRODUCTION

Gosford City Council is carrying out a Review of the Floodplain Risk Management Plan for **Area G2: Pluim Park / Tall Timbers Estate / Mannings Road** within the Cut Rock Creek catchment near Lisarow.

Your local knowledge and personal experiences of flooding in the area will help us in this Review. The extent of the Study Area is shown on the enclosed map.

1

The purpose of this Review is to re-look at the floodplain management measures adopted in the March 1997 study to enable Council to better plan and manage the potential flood risk. We may contact you to discuss some of the information that you provide.

Name: _____

Address: _____

Email: _____ Daytime Phone no: _____

2

How long have you lived or worked in this area?

_____ Years _____ Months

3

Are you aware of flooding from Cut Rock Creek upstream of the railway line? (Please tick one)

☐ Aware ☐ Some Knowledge ☐ Not Aware

4

Has your house floor level ever been inundated by flooding in the past? ☐ Yes (give details) ☐ No

_____

_____

_____

COMMUNITY QUESTIONNAIRE

Cut Rock Creek Catchment – Area G2
Pluim Park/Tall Timbers Estate/Mannings Road
Review of Floodplain Risk Management Plan

5

If your property has been affected by flooding in the past, what damage occurred?

6

If your property has been affected by flooding, how often has this occurred? (Please tick one)

☐ 1 – 10 times ☐ 11 – 20 times ☐ More than 20 times

7

What measures do you think could be taken to manage these flooding problems?

8

Are there any other issues that have occurred as a result of flooding that you consider should be addressed e.g. access to property?

9

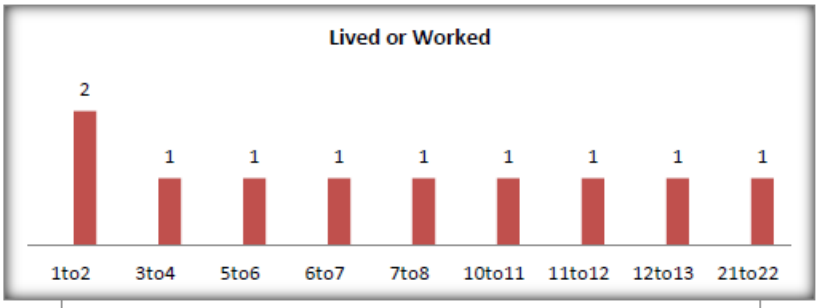
Thank you for your assistance in completing this questionnaire. Your help is greatly appreciated.

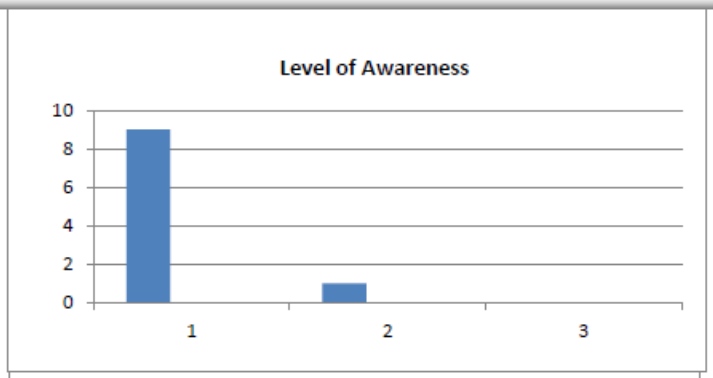
COMMUNITY QUESTIONNAIRE

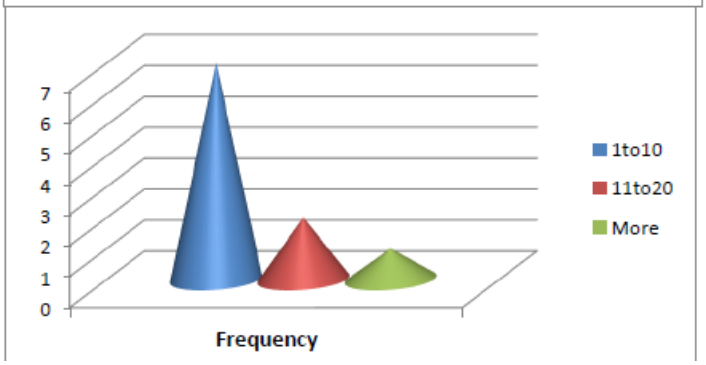
Cut Rock Creek Catchment – Area G2
Pluim Park/Tall Timbers Estate/Mannings Road
Review of Floodplain Risk Management Plan

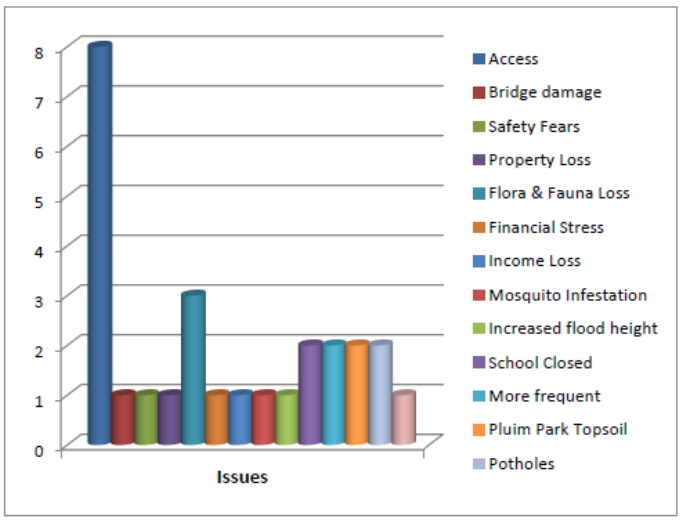
Study Area

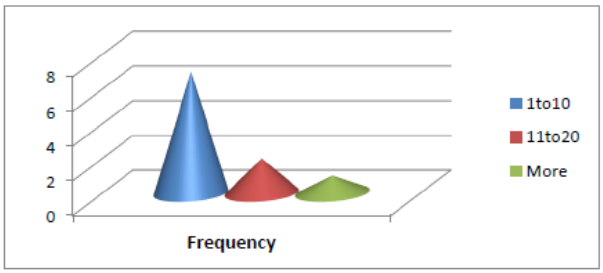
Breakdown of all responses to the questionnaire received from residents











Cut Rock Creek Catchment – Area G2
Pluim Park/Tall Timbers Estate/Mannings Road
Review of Floodplain Risk Management Plan
— Community Information Newsletter May 2013

Introduction

Due to concerns raised by residents regarding access issues during small frequent rainfall events, Gosford City Council appointed WMAwater (formerly Webb McKeown & Associates) in December 2011 to carry out a Review of the 1997 Bangalow and Cut Rock Creek Floodplain Management Plan for **Area G2: Pluim Park/Tall Timbers Estate/Mannings Road**.

The Floodplain Risk Management Plan provides a basis for sound floodplain management planning for the area, which recognises the demands for development and change, the need for good urban and environmental outcomes and the social and economic benefits of reducing flood damage.

FIGURE 1: Study Area

The main flooding issues raised by residents' from the Tall Timbers Estate via a questionnaire and at a meeting held at Ourimbah-Lisarow RSL Club on Monday 30 January 2012 were:

The inundation of the privately owned vehicle access bridge from Tuggerah Street;

Risk to life of children trying to cross access bridge;

Potholes in private access road;

The impact of upstream development on water quantity and quality;

The placement of a series of rocks in the channel, immediately downstream of the highway;

Erosion of the channel;

Frequent nuisance flooding;

Maintenance of the channel (removal of vegetative and other debris);

Odour from sewer systems.

The Review Area

Area G2 comprises the floodplain from Pluim Park downstream to the Sydney-Newcastle railway line and includes the two residential areas of Tall Timbers Estate and Mannings Road.

PHOTOGRAPH 1: View to Tall Timbers Estate from Tuggerah Street

Floodplain Management Process

The following is the process that Council follows in the preparation of a Floodplain Risk Management Plan for each estuary.

The first step in the process, the Flood Study, was completed in 1994.

DIAGRAM 1: The Floodplain Risk Management Process

The second step is the preparation of a Floodplain Risk Management Study (FRMS) that identifies a range of floodplain management measures to address the problems and areas of concern. This was completed in 1997.

The third stage involves the preparation of a Floodplain Risk Management Plan that documents how the proposed measures identified in the FRMS are to be implemented in terms of resources and timing. This was also completed in 1997.

Why this Review is being Undertaken?

This Review is being undertaken to ensure that the past recommended management measures are still appropriate or if new measures should now be considered.

Draft Addendum for Area G2 of the Bangalow Creek and Cut Rock Creek Floodplain Management Plan (1997)

A Draft Addendum is now ready for comment. It is important to gain community input and feedback to ensure all options have been considered and the management measures meet the needs and expectations of the local community.

The Draft Addendum lists recommended management measures that attempts to address issues raised and prioritises them as high, medium or low. Some high priority recommendations have already been implemented. For example, State Emergency Service has visited residents to discuss safety during floods and council is currently investigating the installation of a flood warning system. Vegetation has been cleared from amongst the boulders downstream of the Pacific Highway and contractors had been scheduled to remove sedimentation in the vicinity of the private access bridge area.

Gosford City Council would now like to invite you to attend a workshop to view the outcomes of extensive investigations into the issues raised and discuss the management measures appearing in the Draft Addendum.

PHOTOGRAPH 2: Houses along Mannings Road

How Do I Get Involved?

Community input into the Review of the Floodplain Risk Management Plan for this area is essential and you are invited to attend a workshop at: Gosford City Council Chambers on Monday 17June 2013 commencing at 7pm.

Please RSVP before Friday 7 June 2013 if you will be attending.
Sally Smith on 4325 8385

Appendix C

Catchment Management Authority
Hunter–Central Rivers

Cut-Rock Creek in the vicinity of Tuggerah Street Lisarow is a laterally unconfined alluvial stream with the capacity for vertical and lateral adjustment within its floodplain. Due to non-cohesive bank sediments (fine – medium sands), banks are highly sensitive to erosion; an intact riparian buffer of approximately 5 -10 m on both banks is largely responsible for bank stability at the site. Although a significant portion of the riparian vegetation comprises exotic species such as privet (*Ligustrum spp.*) and camphor laurel (*Cinnamomum camphora*) there are many local native species present. In sand-bed streams, riparian vegetation plays a critical role in the creation of pools and riffles, provision of structural habitat and food resources for aquatic biodiversity.

Several large camphor laurel trees on both banks of Cut-Rock Creek have fallen into the channel creating a partial blockage (debris dam) directing floodwaters to the stream banks and causing localised erosion. It is likely that some of the trees have fallen into the channel due to previous basal scour and undercutting. Flood debris, primarily comprising small branches and other vegetative matter is accumulating behind the fallen trees, further reducing channel capacity in flood flow and increasing localised scour and slumping.

The most significant erosion is occurring on the left bank; basal scour has resulted in a 5 m x 2 m section of bank slumping by around 0.5 m. This feature is fairly well vegetated although some of the larger shrubs are tilting towards the channel, indicative of roots shearing off as the bank slumped. The channel was also inspected for approximately 30 m upstream of the debris dam and it was noted that basal scour, undercutting and slumping had also occurred on a number of the outer (concave) banks.

If the debris dam experiences a net increase in woody debris, greater volumes of flood flow will be directed against the left bank resulting in additional bank erosion. However, due to bank stability afforded by the riparian buffer and nature of the erosion processes at the site, additional scour and slumping is likely to remain localised and is not considered to pose a significant risk to infrastructure in the immediate vicinity. Needless to say, volumes of sediment released through bank erosion do have the capacity to cause a range of negative impacts downstream. These include possible reductions in channel capacity, sedimentation, and burial of in-stream habitat. However, in light of the localised nature of the bank erosion at the site and significant riparian buffer, intervention is not considered necessary at this stage. It is recommended that the site is monitored, particularly after bank-full (or greater) flood events; if significant net accumulation of debris causes further bank collapse, this may necessitate the removal of some debris in-stream and/or minor structural works. The riparian buffer should be maintained with the removal of exotic species and replacement with local natives a long-term management aim.

Daniel Keating – CAP Implementation Officer, Vegetation & Riparian

13.08.13

PO Box 600 WYONG NSW 2259 – 3/34-36 Pacific Highway WYONG

Tel: 02 4352 5100 - Fax: 02 4352 5120 - ABN: 50 602 456 909

SUMMARY

• PRIORITY LISTING OF RECOMMENDED FLOODPLAIN MANAGEMENT MEASURES

MEASURES	COMMENT
HIGH PRIORITY	
STRUCTURAL MEASURES:	
Channel Works near Brands Place at Lisarow (Gosford City Council)	Will prevent 23 buildings from being flooded in the 1% event. Cost $610 000 with a benefit/cost ratio of 0.4. Concern regarding land resumption costs.
Realignment and Clearing of Channel from Teralba Street to the Pacific Highway (Gosford and Wyong Councils)	Any developer of flood liable land between Teralba Street and the Pacific Highway downstream, will be required to contribute to the proposed works as described in Appendix B of the Plan. Works to be undertaken by the developer at no cost to Council.
Retarding Basin Chamberlain Rd/MacDonalds Rd (Gosford City Council)	Site to be retained for a future basin. This site was identified in DCP8 for the Lisarow area and funds are available from Section 94 Contributions.
Maintenance of Creek Channel (Gosford and Wyong Councils)	Both Councils are to maintain the existing creek system to ensure that excessive vegetation, debris and silt do not significantly reduce the hydraulic capacity. Cost $10 000 per annum per Council.
Donna Close - Channel Works to contain the 1% flood and prevent inundation of private property. (Gosford City Council)	Cost $270 000. The cost to undertake these works will be partially funded from Section 94 Contributions. These works reduce flood damages and hazard.
Pluim Park "hole" in Mound (Gosford City Council)	These works will lower flood levels by up to 0.05m in a 20% event and allow the soccer fields to be used as a flood storage area during minor events. Cost $10 000, to be undertaken by the Soccer Association.
Tall Timbers - Access during floods (Gosford City Council)	Improve access by raising the private road. Cost is $80 000 with a benefit/cost ratio of 0.5. The responsibility for funding of these works has to be determined.
Bank Protection - Tall Timbers Estate (Gosford City Council)	Prevent further erosion of the creek bank. Cost $50 000.

SUMMARY

MEASURES	COMMENT
HIGH PRIORITY	
NON-STRUCTURAL MEASURES:	
Control on Upstream Catchment Development (Gosford and Wyong Councils)	Close monitoring of proposed development is required by the two Councils. Future designs to include the use of measures to minimise increases in peak flow and water quality degradation. No cost to Council.
Amend S149 Planning Certificates (Gosford and Wyong Councils)	Update the S149 Planning Certificates to include the latest information regarding flooding.
Information/Education (Gosford and Wyong Councils)	Will ensure future damages are minimised by providing regular advice to all flood affected landowners. Cost $5000 per annum per Council.
Additional Information on Flood Hazard (Gosford City Council)	Information regarding the likely hazard in evacuating from a rural property during floods is available upon request. This should include a Flood Evacuation Plan for Lisarow Primary School.
Flood Evacuation Plan for the University Campus (Wyong Council)	To be prepared by the University to Council's satisfaction.

MEDIUM PRIORITY	
NON-STRUCTURAL MEASURES:	
Local Structural Works (preventing the ingress of floodwaters) and House Raising (Gosford and Wyong Councils)	Measure is supported by both Councils. Full (approximately $40 000) or part subsidies (say $10 000) can be obtained from State and Federal funds.
Flood Warning (Gosford and Wyong Councils)	Ready-Set-Go study supported. No cost to Councils.
Lisarow Primary School (Gosford City Council)	Relocation of the school. Cost unknown.

SUMMARY

MEASURES	COMMENT
LOW PRIORITY	
NON-STRUCTURAL MEASURES:	
Retarding Basins (Gosford and Wyong Councils)	Councils to resolve whether potential sites for retarding basins in the upper catchment should be set aside.
Collect and analyse more data to gain a better understanding of flood behaviour (Gosford and Wyong Councils)	Install and maintain additional Maximum Height Recorders. Collect and analyse data from future floods to increase understanding of flood behaviour and ensure accuracy of the design flood levels. Cost $5000 per annum per Council.
Catchment Treatment (e.g. re-afforestation or minimisation of impervious areas) (Gosford and Wyong Councils)	Will not reduce the existing flood problem but can be undertaken for minimal cost to Councils or landowners.
Flood Runner Channel connecting Cut Rock Creek to Bangalow Creek near Mannings Road (Gosford and Wyong Councils)	Alignment of proposed channel to be retained as far as possible in its existing state. Further consideration of this is required during the design of the proposed arterial road. No cost to Councils.
STRUCTURAL MEASURES:	
Re-alignment and clearing of channel from Teralba Street to the Pacific Highway (Gosford and Wyong Councils)	These works to be undertaken, as described in Appendix B of the Plan (and in High Priority Items), if not undertaken by a developer.

SUMMARY

• DEVELOPMENT STRATEGIES - LOCAL (GOSFORD AND WYONG COUNCILS)

ISSUE	RESPONSE
Council's Floodplain Management Policy	All further development must be in accordance with Council's Floodplain Management Policy. Further details are given below.
Guidelines for Approved Development within the Floodplain (Gosford City Council Policy)	Floor levels of all new buildings to be at a minimum of 0.5m above the 1% flood level and 0.3 m above the surrounding ground level. Fill levels to be 0.3m above the 1% flood level. Garage floor levels to be at or above the 1% flood level. No cost to Council.
Guidelines for Approved Development within the Floodplain (Wyong Council Policy)	Floor levels of all new buildings to be at a minimum of 0.3m above the 1% flood level. Fill levels to be to the 1% flood level. No cost to Council.
Further Subdivision of Land within the Floodplain	No further subdivision should be permitted if it will increase the number of residents living in the floodplain and therefore the risk to life.
Filling on the Floodplain (Gosford and Wyong Council Policy) (Gosford City Council only)	Subject to the following guidelines: . filling is not recommended in a Floodway, . filling will be considered in a Flood Storage/Fringe area for construction of a building pad for residential use up to 500 m^2. A cut/fill approach must be adopted and the filling must not restrict overland flow paths, and not adversely affect adjoining properties, . the importation of fill is not permitted.
Renovations or Extensions to Existing Buildings including Landscaping and Fences	Works on the floodplain will only be permitted if they can be shown to have minimal impact upon the flood flow characteristics of the area and comply with the other strategies.
Access to Properties during Floods	No development will be permitted unless the developer can assure Council that access to and from the site during floods has been adequately addressed.
Control of Future Catchment Development	To ensure the flood problem is not exacerbated. No cost to Council.
On-Site Detention	Will assist in reducing increases in peak flow following catchment development. No cost to Council for works.

• DEVELOPMENT STRATEGIES - GENERAL (GOSFORD AND WYONG COUNCILS)

ISSUE	RESPONSE
Greenhouse Effect	To be monitored.
Future roadworks or construction/maintenance of other major public works on the floodplain.	Council or any other constructing authority must ensure that the proposed works will not significantly affect flood levels or flows elsewhere.
Future Bridge Upgrade Work	Prior to the design of any bridge or creek crossing by public authorities (such as the SRA or RTA) hydraulic analysis should be undertaken to assess the impacts upon flooding. No cost to Council.
Further Development of Pluim Park	Conditional upon the guidelines provided in Appendix C of the Plan.
Water Quality	Both Councils will ensure that as far as possible any approved works in the creek or in the catchment will not adversely affect the water quality downstream.
Liaison between Gosford and Wyong Councils	Each Council should be advised (in writing and given the right of reply) of any development within the other Council area which may have an impact on flooding or water quality within its Council area.

A detailed cost estimate for the proposed works for each area, and benefit/cost ratios, are provided as Appendix D. The benefits only include the reduction in tangible damages to buildings (internal and external) and do not include tangible damages to public utilities (roads, reserves, etc.). Intangible flood damages (anxiety, flood hazard, etc.) will also be reduced, and would therefore increase the benefit/cost ratio if quantified.

The key features of the Plan are:

- *the 1 % flood is to continue as the Designated Flood Standard, and the Minimum Floor Level established as 0.5 m above the 1 % flood (Gosford City Council) and 0.3 m above the 1% flood (Wyong Council - subject to possible future amendment),*
- *definition of the 1 % flood extent and identification of properties subject to Minimum Floor Level requirements on the S149 Planning Certificates for Gosford City Council; definition of the 1% flood levels for Wyong Council,*
- *a priority listing of flood mitigation strategies has been adopted to ensure that all properties inundated above floor level in a 1 % flood are offered some form of protection,*
- *criteria for the future development of the upper catchment have been determined. These will ensure that the volume of runoff and peak flows are not increased significantly downstream and the impact on water quality and sedimentation is minimised,*
- *filling of the floodplain may be permitted subject to adherence to Council's guidelines,*

SUMMARY

- *both Councils will provide information and education to the local residents in order to ensure that flood damages in the future are minimised,*
- *further data will be collected and studies undertaken to increase our understanding of flood behaviour and improve the accuracy of the design flood levels,*
- *the practice of house raising or local structural works (preventing the ingress of floodwaters to buildings) is encouraged by both Councils. Funding for house raising can be obtained either as fully funded (say $40 000 per building) or partially funded (say $10 000 per building),*
- *both Councils will amend the S149 Planning Certificates in accordance with this study,*
- *both Councils will ensure that the creek channel is continually maintained and free from excessive silt and debris, particularly under bridges, to ensure minimal impact on flood flows,*
- *applicants or property owners will be advised to make fences and home improvements flood compatible, ensuring minimal hydraulic impact, or to move such works outside the floodplain,*
- *both Councils support any measures which will increase the amount of flood warning time available to the residents,*
- *each Council will inform the other of developments likely to change flood conditions or water quality in the other Council area.*