

Figure G - 16: Distribution of vulnerable building elements in the northern Lake Macquarie area

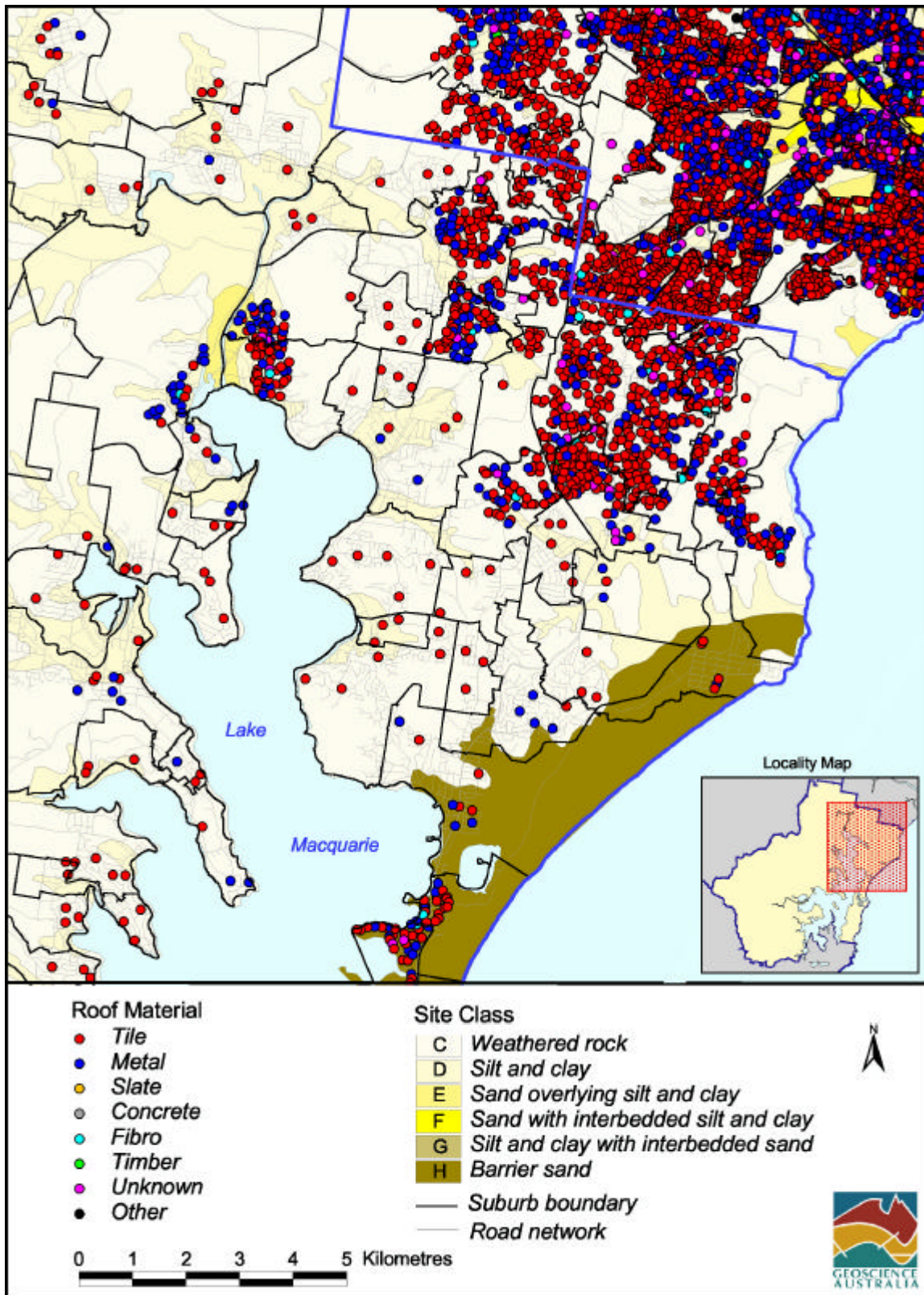


Figure G - 17: Distribution of vulnerable building elements in the southern Lake Macquarie area

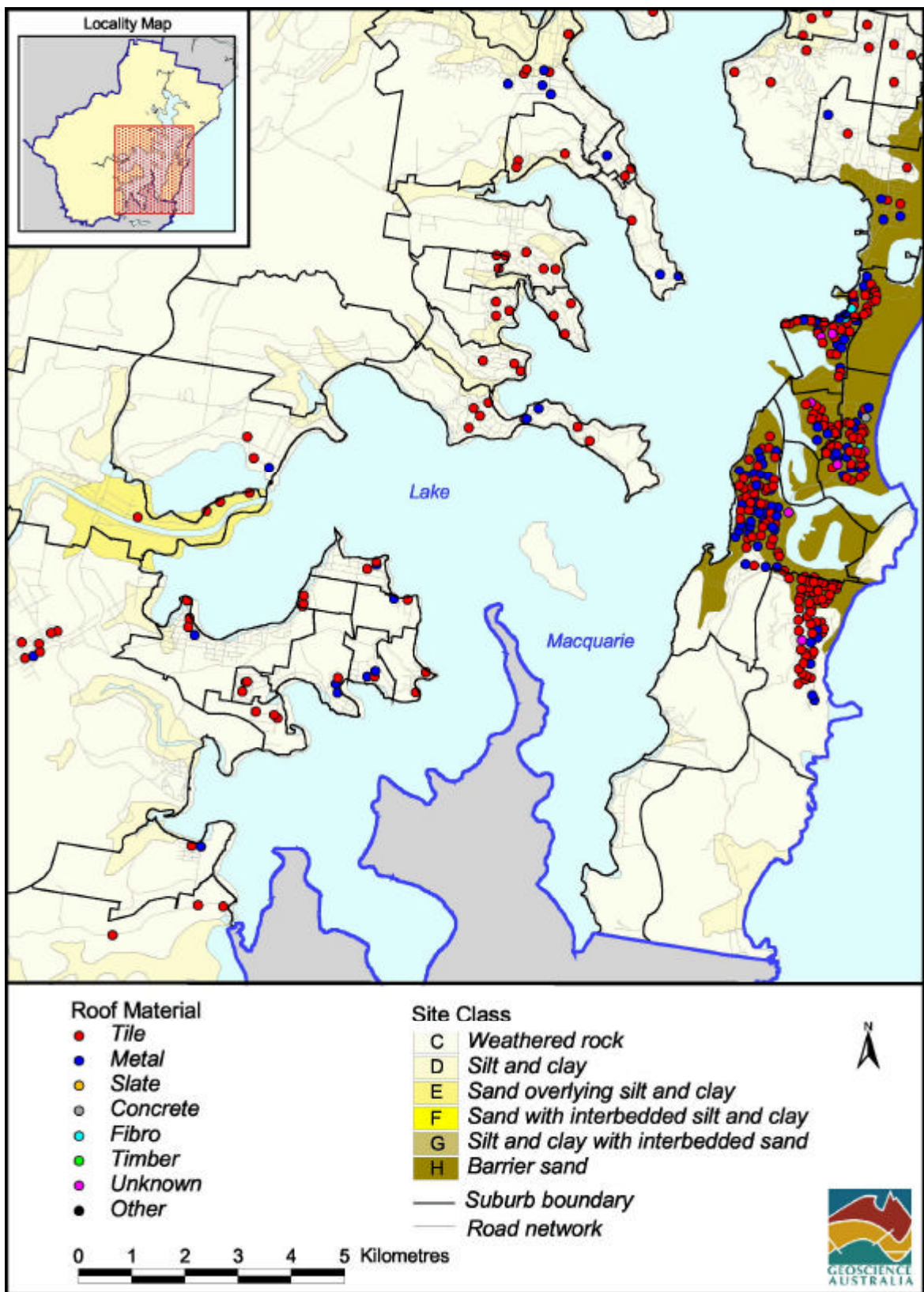


Figure G - 18: Distribution of vulnerable building elements in the southern Lake Macquarie area

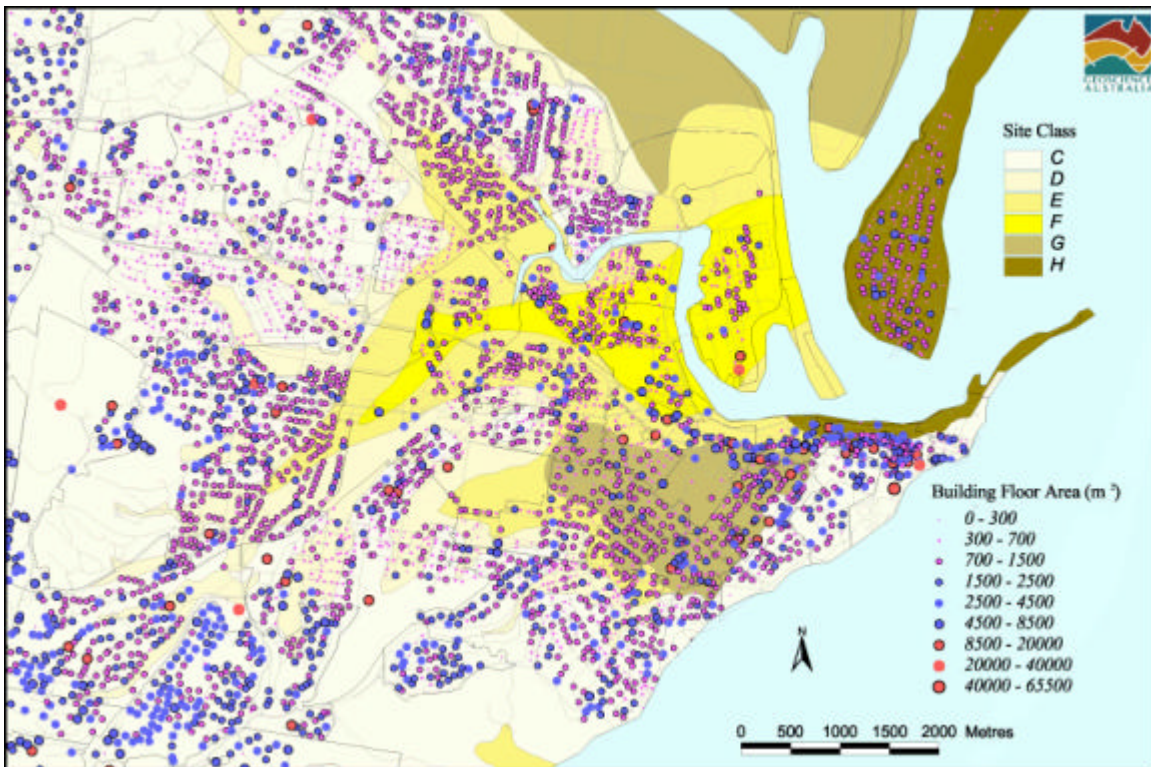


Figure G - 19: Distribution of survey sites in the Newcastle area

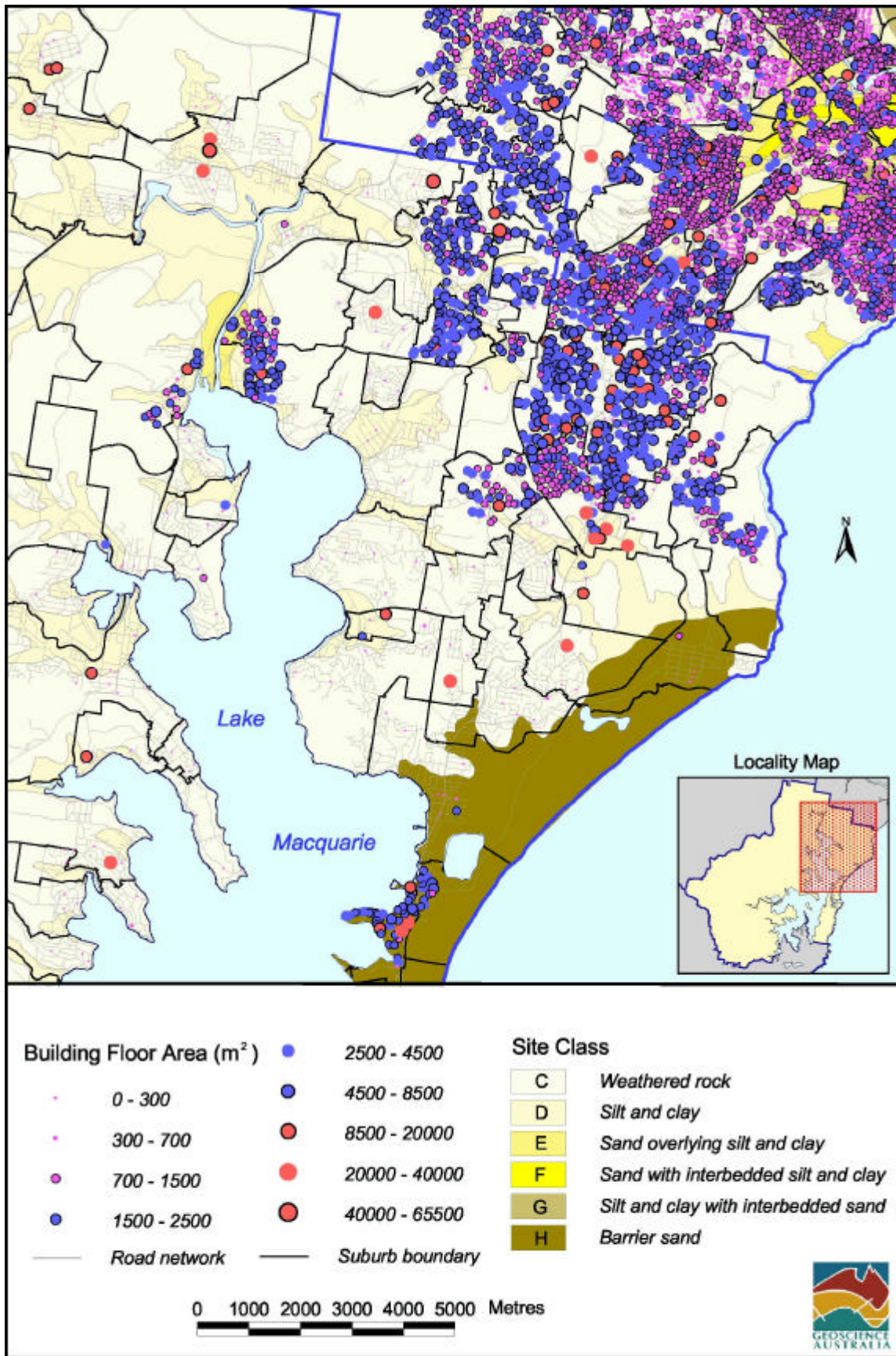


Figure G - 20: Distribution of survey sites in the northern Lake Macquarie area

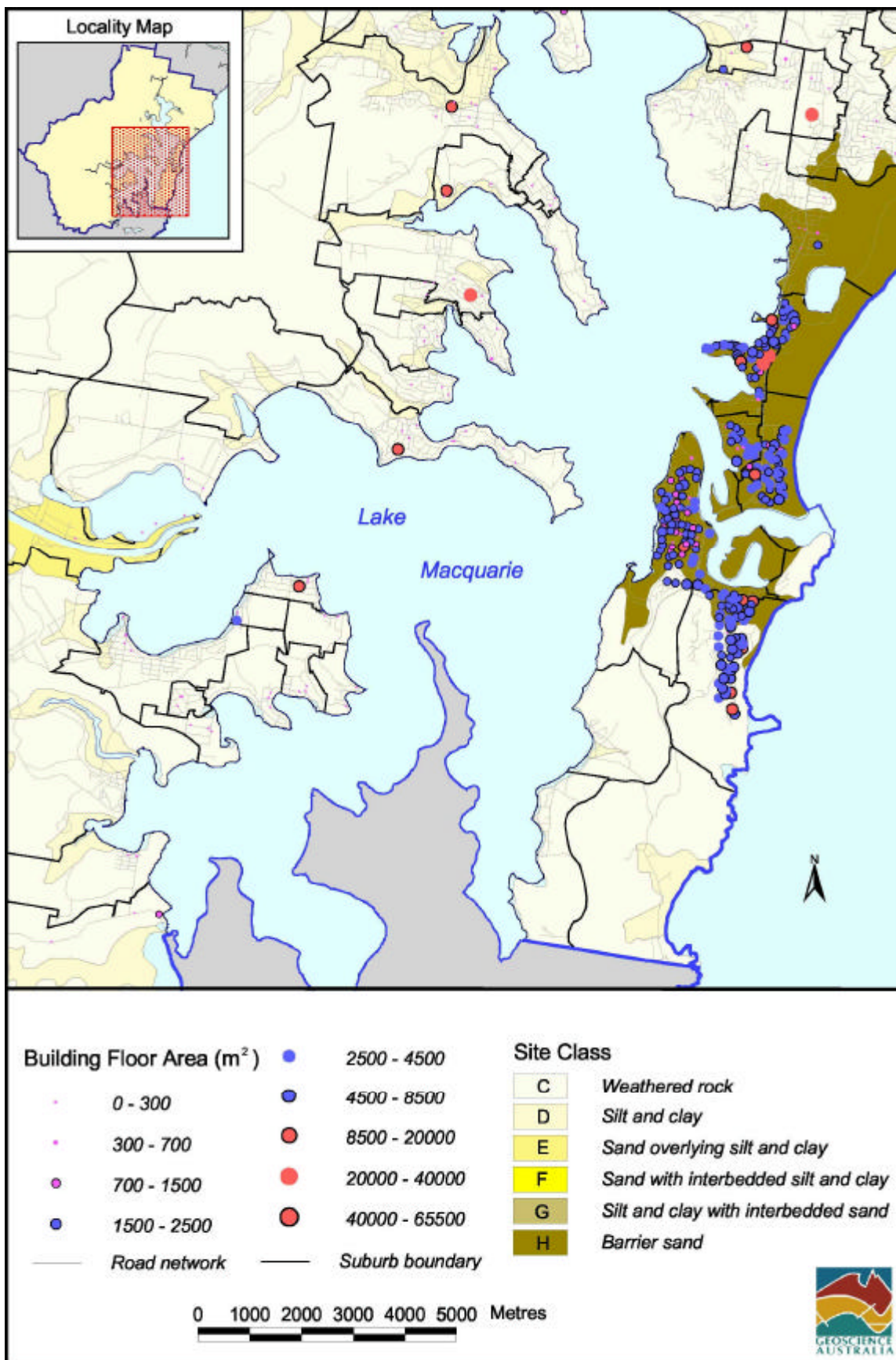


Figure G - 21: Distribution of survey sites in the southern Lake Macquarie area

The structural type and the usage of a building are important indicators of building earthquake performance. For the performance modelling methodology used in the risk assessment process, the structural type determines the structural performance characteristics and the usage type determines the non-structural performance characteristics and the relative value of the structural, non-structural and contents components of the building.

The structural type and usage definitions used within the risk assessment process are based on definitions employed in HAZUS (National Institute of Building Sciences, 1999). Hence, from the building data which was collected, buildings were classified into the relevant HAZUS classes, according to HAZUS class definitions. There is some difficulty in assigning HAZUS classes based upon survey data which gathers information only about the exterior of a building. The greatest problem is in being able to determine the structural class based upon only information about the external cladding, the estimated building age and other relevant information. A particularly common problem is in being able to determine whether a building is a timber framed brick veneer or a double-leafed unreinforced masonry structure. To aid the classification process, the local building expertise of Mr. Robert Boyce of the City of Newcastle, was called upon. Mr. Boyce was able to provide an estimate of the building type percentages, given an exterior skin of brickwork and the building age. These estimates are given in [Table G - 13](#). Also, for buildings with an external brick skin, more than two storeys high and built after 1950, it is assumed that the structure is a reinforced concrete frame with masonry infill walls.

Table G - 13: Classification of building type given an exterior brick skin

Age	Unreinforced masonry (Double brick or English bond)	Timber frame (Brick veneer)	Reinforced concrete frame with masonry infill (if above 2 storeys)
Up to 1900	100%	0%	0%
1901 up to 1930	100%	0%	0%
1931 up to 1950	90%	10%	0%
1951 up to 1960	80%	20%	100%
1961 up to 1970	10%	90%	100%
1971 up to 1980	1%	99%	100%
1981 up to 1990	1%	99%	100%
1991 up to 2000	1%	99%	100%
Under Construction	1%	99%	100%

For larger commercial buildings, the structural type is not always obvious either. Hence the assumptions expressed in [Table G - 14](#) have been made for classification according to HAZUS structural types. Where a building structural type can not be classified upon this criteria, the structure is assumed to be a “W1” type if the building is used for accommodation purposes, otherwise it is assumed to be a reinforced concrete moment resisting frame, classified according to the number of storeys. The classification method adopted to determine the appropriate HAZUS building usage type is shown in [Table G - 15](#). Where a building usage type can not be classified upon this criteria, it is assumed that the building is a “RES1” type if the building is used for accommodation purposes, otherwise it is assumed to be a “GOV1” type. It should be noted that not all HAZUS structural and usage types are used, due to mainly the non-existence of many types. It may also be noted that not all the detail collected by the survey process is actually used in building type classification. However, it is hoped that with further research, building vulnerability types may be developed that make use of more of the information, especially where particular building attributes are known to make structures highly vulnerable.

The spatial distribution of buildings are mapped in [Figure G - 22](#) - [Figure G - 29](#) according to HAZUS building structural type and building usage.

Table G - 14: Classification of HAZUS structural types

HAZUS structural type	Brief description	Number of storeys	Surveyed external wall type	Number of classifications
W1	Wood, Light Frame	1-2	Timber, Fibro, Masonite, Brick (according to age), Metal (if for accommodation)	4711
S1L	Steel Moment Frame	1-3	Metal	6
S1M	Steel Moment Frame	4-7	Metal	1
S1H	Steel Moment Frame	>7	Metal	1
S3	Steel Light Frame	1	Metal	28
C1L	Reinforced Concrete Moment Resisting Frame	1-3	Glass, Reinforced Concrete (If "SOFT STOREY", "IRREGULAR" or "OPEN", otherwise 50% chance C1L or C2L)	64
C1M	Reinforced Concrete Moment Resisting Frame	4-7	Glass, Reinforced Concrete (If "SOFT STOREY", "IRREGULAR" or "OPEN", otherwise 50% chance C1M or C2M)	13
C1H	Reinforced Concrete Moment Resisting Frame	>7	Glass, Reinforced Concrete (If "SOFT STOREY", "IRREGULAR" or "OPEN", otherwise 50% chance C1H or C2H)	6

HAZUS structural type	Brief description	Number of storeys	Surveyed external wall type	Number of classifications
C2L	Concrete Shear Walls	1-3	Glass, Reinforced Concrete (50% chance C1L or C2L)	19
C2M	Concrete Shear Walls	4-7	Glass, Reinforced Concrete (50% chance C1M or C2M)	5
C2H	Concrete Shear Walls	>7	Glass, Reinforced Concrete (50% chance C1H or C2H)	4
C3L	Concrete Frame Buildings with Unreinforced Masonry Infill Walls	1-3	R/C Frame with Brick\Masonry Infill, Brick (according to age and height)	83
C3M	Concrete Frame Buildings with Unreinforced Masonry Infill Walls	4-7	R/C Frame with Brick\Masonry Infill, Brick (according to age)	21
C3H	Concrete Frame Buildings with Unreinforced Masonry Infill Walls	>7	R/C Frame with Brick\Masonry Infill, Brick (according to age)	16
PC1	Precast Concrete Tilt-Up Walls	Any	Pre-Cast Concrete	30
URML	Unreinforced Masonry Bearing Walls	1-2	Masonry, Stone and Brick (according to age)	1218
URMM	Unreinforced Masonry Bearing Walls	>3	Masonry, Stone and Brick (according to age)	89

Table G - 15: Classification of HAZUS usage types

HAZUS usage type	Brief description	Surveyed Industry	Surveyed Category	Surveyed Type	Number of classifications
RES1	Single Family Dwelling (Detached House)	Accommodation	House	Single	4935
RES2	Mobile Home	Accommodation	Caravan Park	Any	4
RES3	Multi-Family Dwelling (Apartments/Flats)	Accommodation	House	Attached, Multiple or Duplex	410
RES4	Temporary Lodging (Hotel/Motel)	Accommodation	Hotel or Motel	Any	43
RES6	Nursing Home	Accommodation	Hostel	Any	5
COM1	Retail Trade (Shops)	Any	Any	Shop, Mall or Supermarket	224
COM4	Professional/Technical Services (Offices)	Any	Any	Office	106
COM6	Hospital	Medical	Any	Hospital	10
COM7	Medical Office/Clinic	Medical	Any	Surgery, Centre, Home, Clinic or Hospice	58
COM8	Entertainment and Recreation	Community	Any	Any	122

Appendix G – Building Inventory

HAZUS structural type	Brief description	Surveyed Industry	Surveyed Category	Surveyed Type	Number of classifications
IND1	Heavy Industry (Factory)	Any	Automobiles or Other	Any	16
IND2	Light Industry (Factory)	Manufacturing	Any	Any	15
IND3	Food/Drugs/Chemicals (Factory)	Storage or....	Food or.....	Service Station	26
REL1	Church	Any	Religion	Any	84
GOV1	General Government Services (Office)	Government	Any	Any	127
GOV2	Emergency Response (Police/Fire Station)	Safety	Any	Any	19
EDU1	Schools	Education	Pre-School, Childcare, School or Convent	Any	103
EDU2	Colleges and Universities	Education	University or College	Any	8

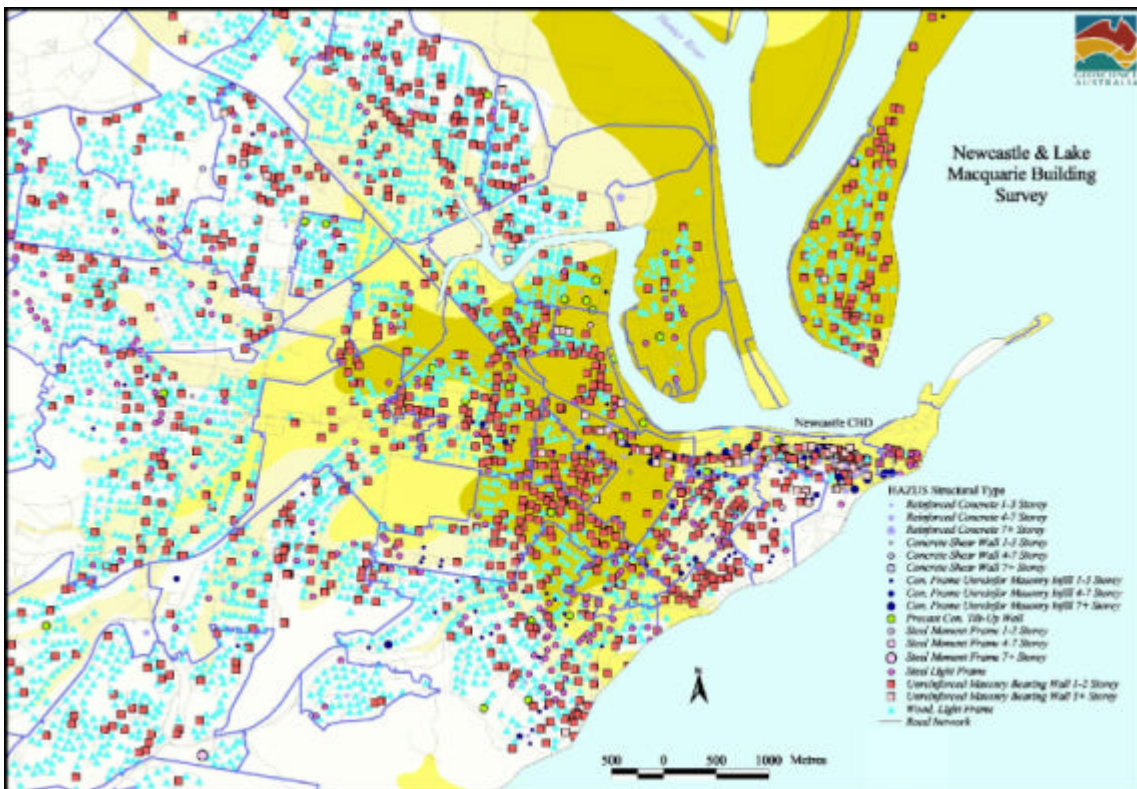


Figure G - 22: Distribution of HAZUS building structural type in the Newcastle area

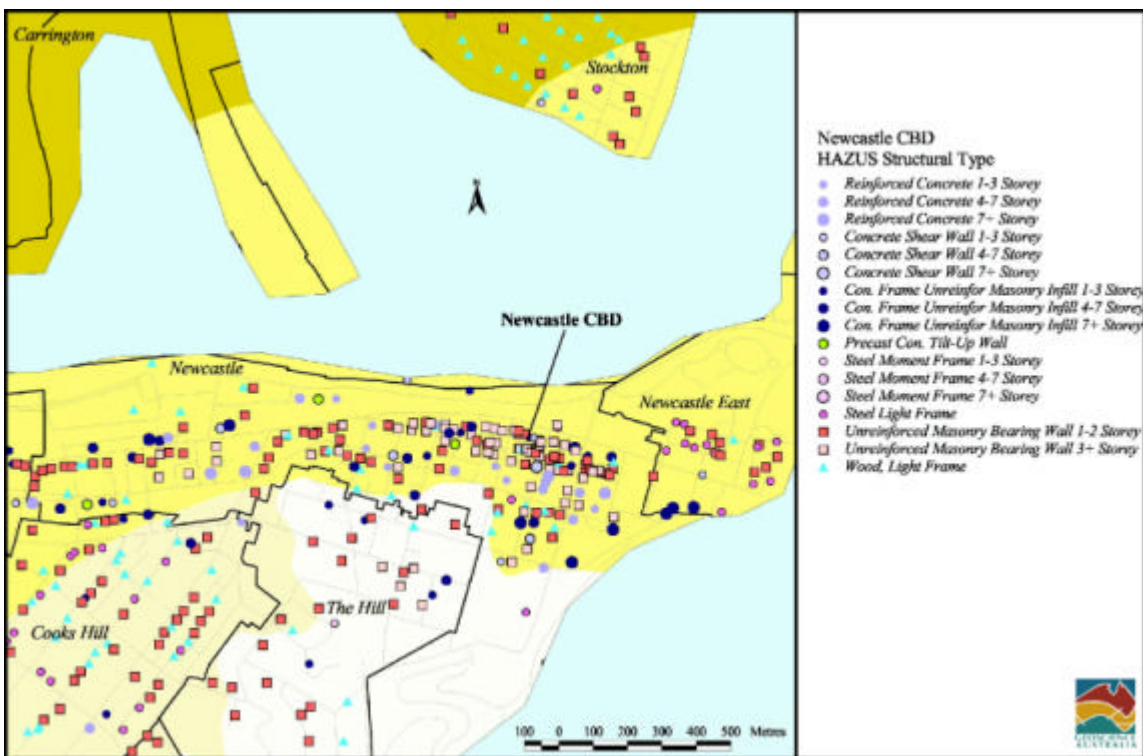


Figure G - 23: Distribution of HAZUS building structural type in the Newcastle CBD

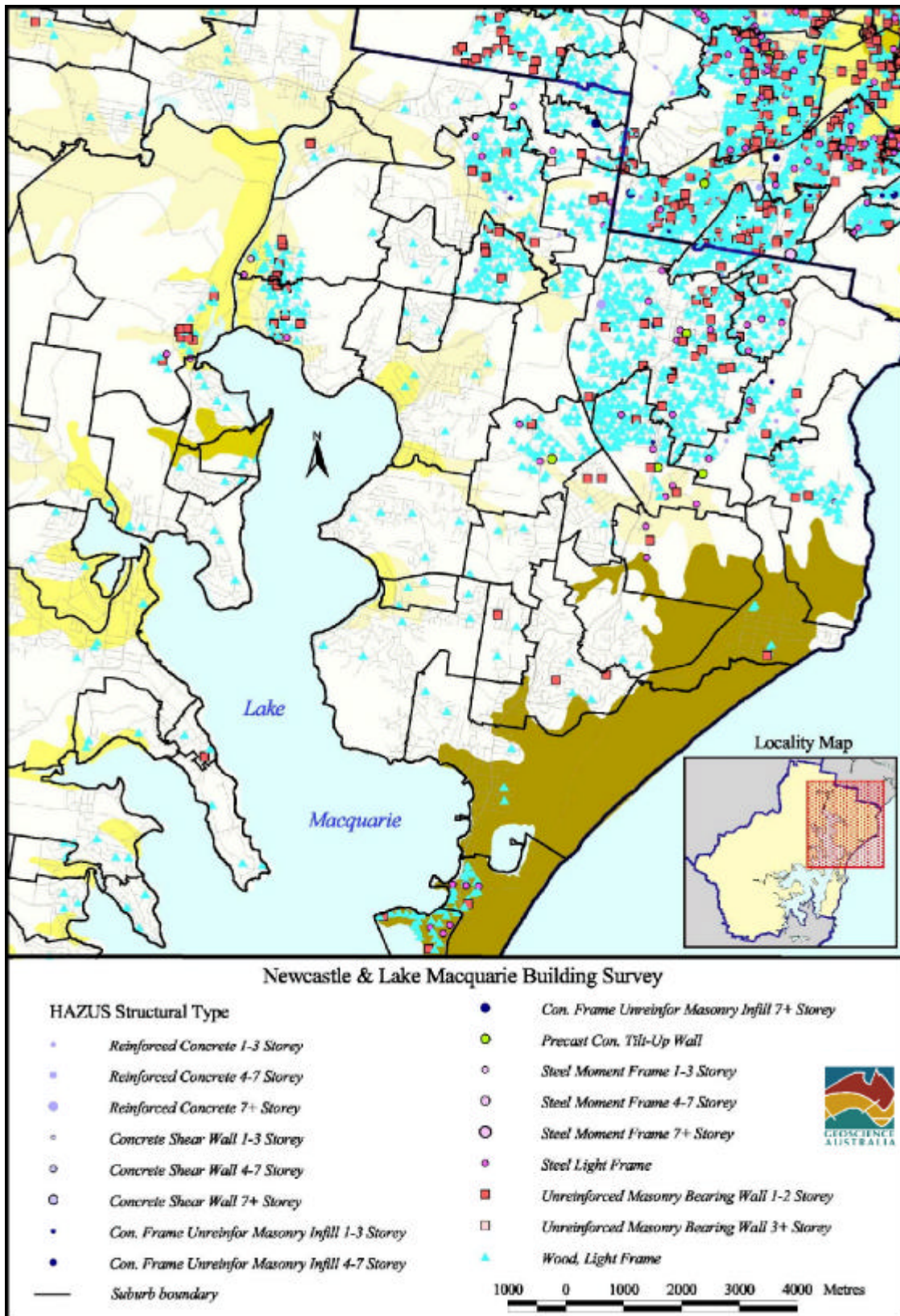


Figure G - 24: Distribution of HAZUS building structural type in the northern Lake Macquarie area

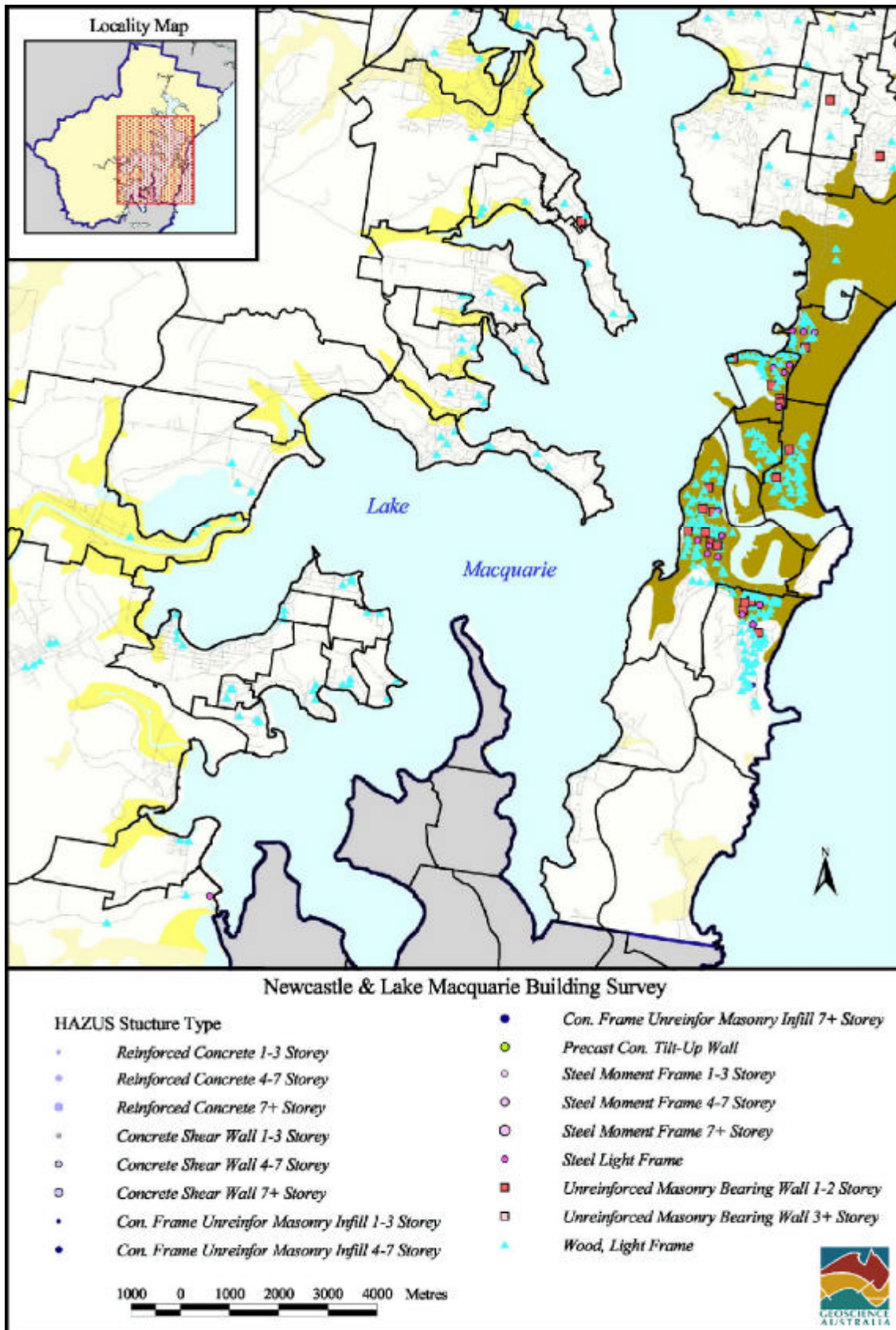


Figure G - 25: Distribution of HAZUS building structural type in the southern Lake Macquarie area

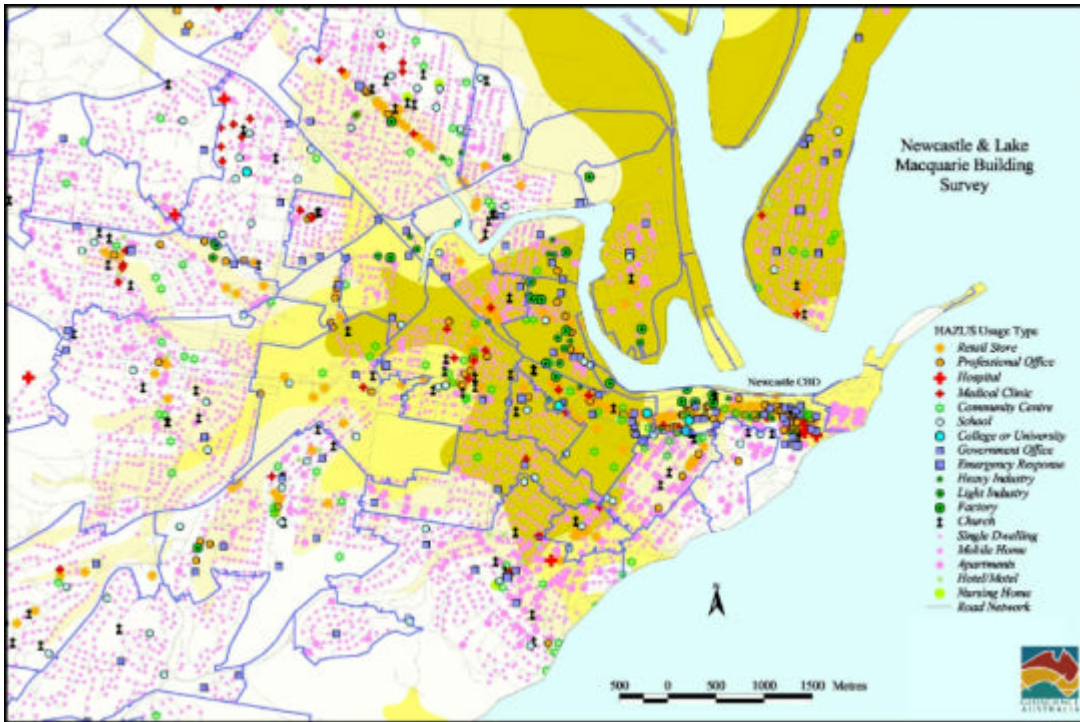


Figure G - 26: Distribution of HAZUS building usage type in the Newcastle area

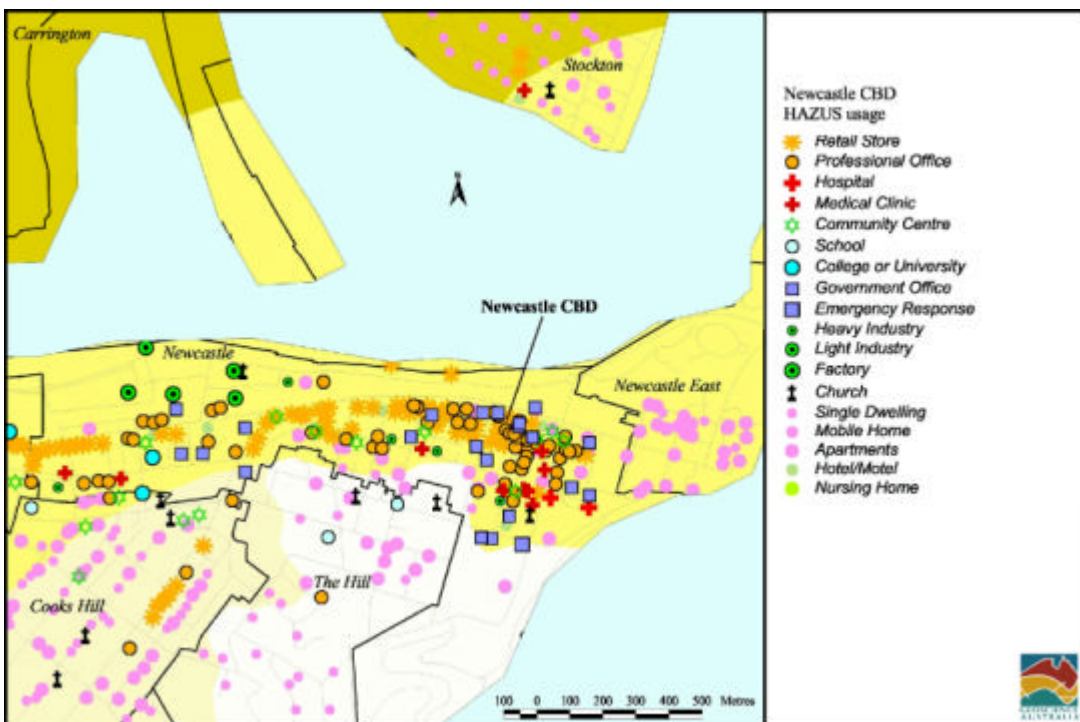


Figure G - 27: Distribution of HAZUS building usage type in the Newcastle CBD

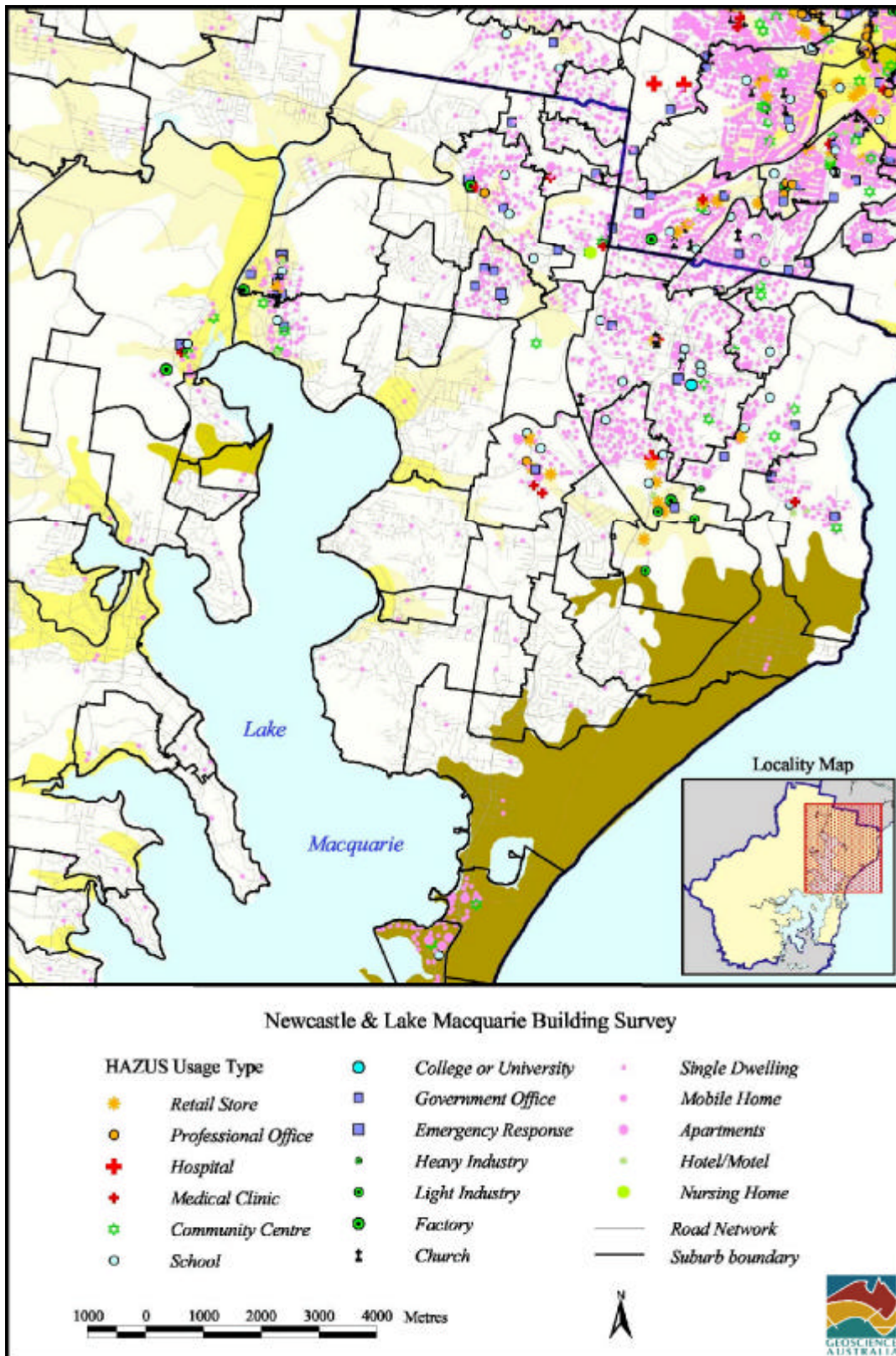


Figure G - 28: Distribution of HAZUS building usage type in the northern Lake Macquarie area

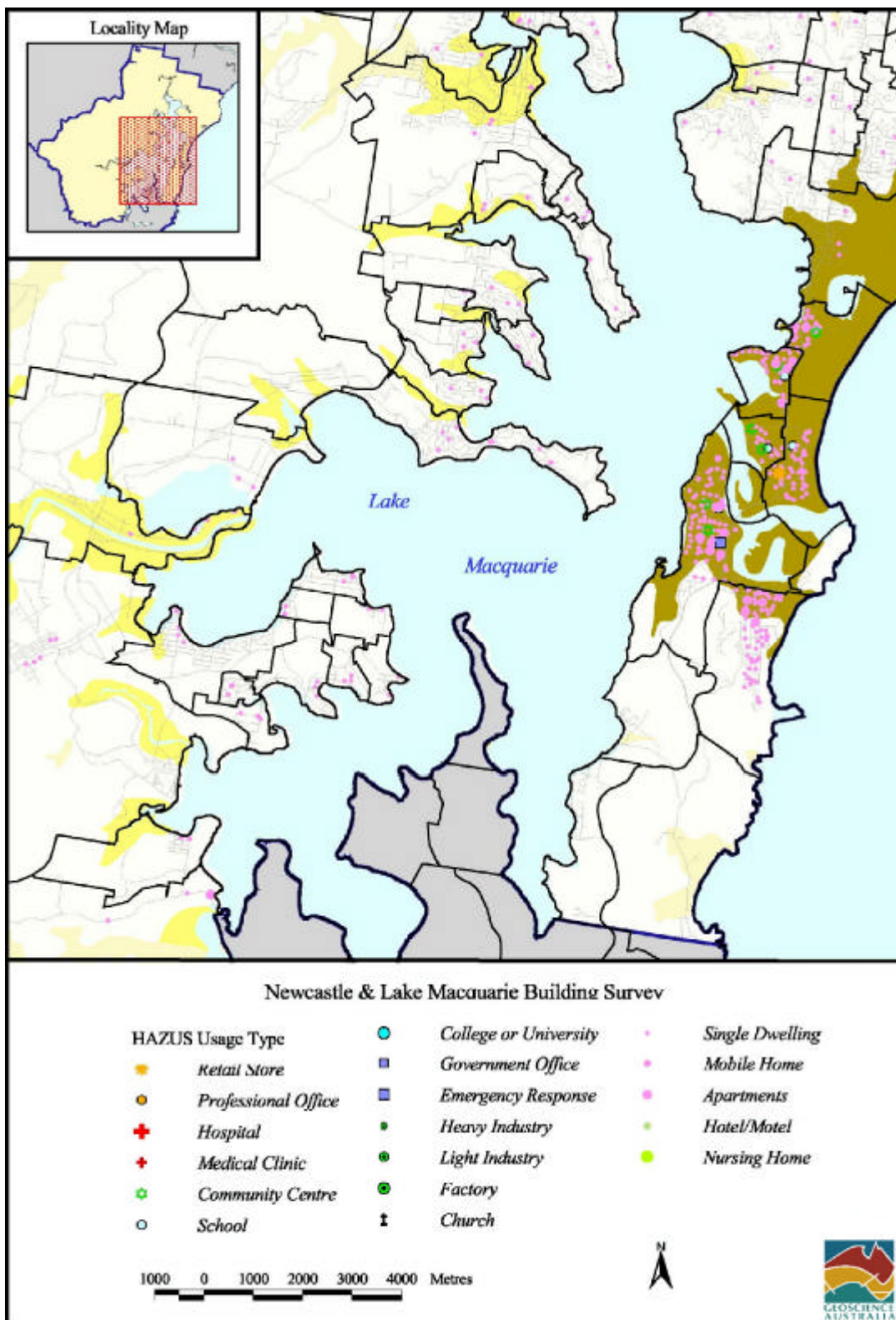


Figure G - 29: Distribution of HAZUS building usage type in the southern Lake Macquarie area