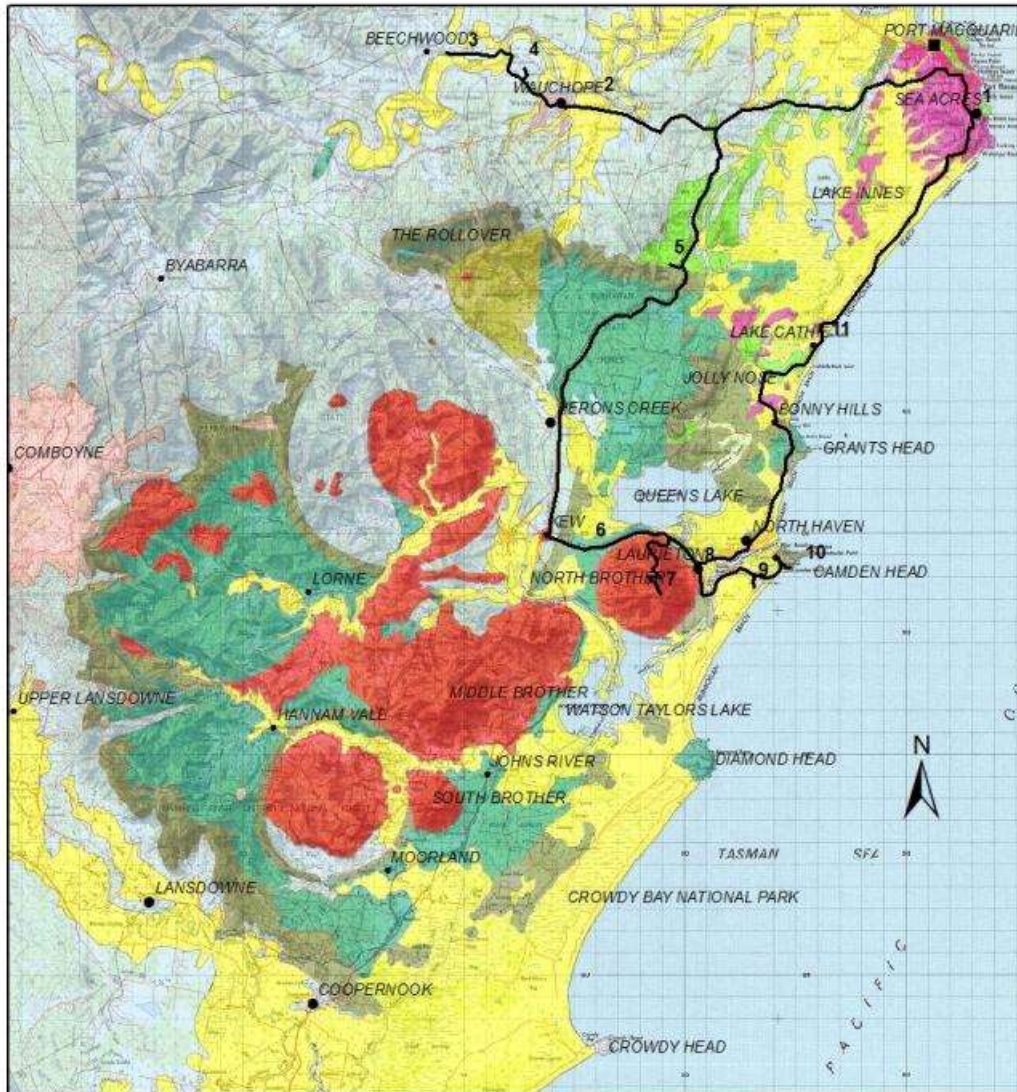



Assessment Team field trip May 2015
REGIONAL GEOLOGY

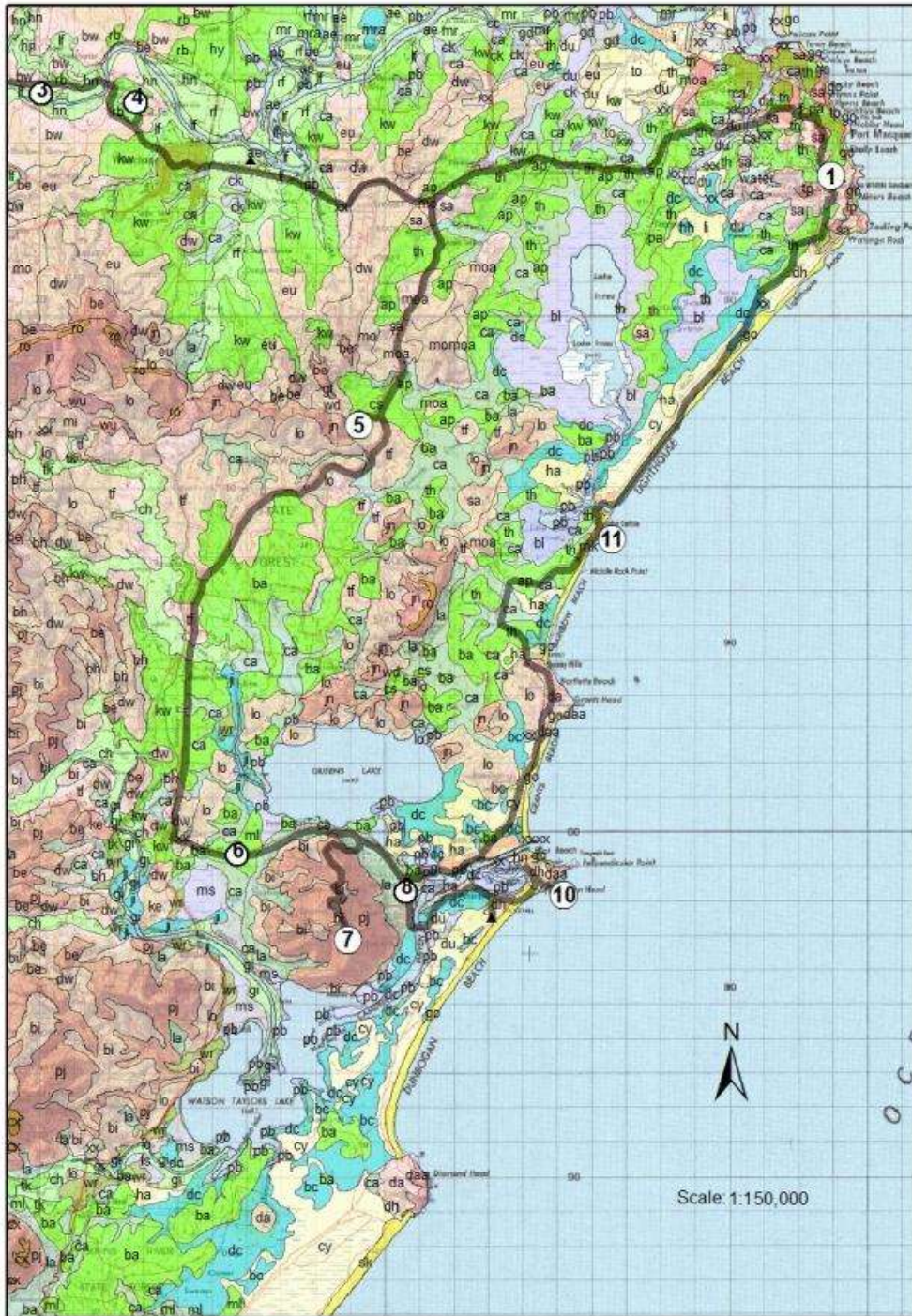


GEOLOGY

- | | |
|---|---|
|  Quaternary sediments |  Permian Manning Group sediments |
|  Tertiary intermediate volcanics |  Devonian-Carboniferous Hastings Block sediments |
|  Tertiary basic volcanics |  Devonian Tamworth Block sediments |
|  Triassic microgranites |  Silurian-Devonian Port Macquarie Block metamorphics |
|  Triassic Lorne Basin volcanics |  Silurian-Devonian Central Block metamorphics |
|  Triassic Lorne Basin sandstones and mudstones |  Palaeozoic fault zone complex |
|  Triassic Lorne Basin conglomerates | |

Scale 1:250,000

Assessment Team field trip May 2015
SOIL LANDSCAPES



Assessment Team field day, May 2015

Site 1. Port Macquarie. The **Port Macquarie Block** is a small entity in the Port Macquarie area at the eastern end of the southern New England Fold Belt. It is a Cambrian – Silurian ocean floor subduction accretionary complex, a detached outlier of the extensive Woolomin Block to the northwest. Ultramafics occur in the fault zone along the southern and eastern boundaries and dolerite dykes (Karikeree Metadolerite) and serpentine intrude the block, usually parallel to northerly trending fault lines. Deep regolith development is common on the Port Macquarie Block. The major rock unit is the Watonga Formation (SDw): intensely deformed chert, slate and basalt, attaining greenschist facies metamorphism (Leitch 1980, Leitch *et al.* 1990).

Admire the deeply weathered Regolith and Red Ferrosols soils. Much of the area is BSAL and market gardens and horticulture were once common; consider the implications for food security when BSAL land is covered by urban development.

Apanie (ap), Sea Acres (sa), Moripo (mo) and Thrumster (th) soil landscapes.

Site 2. Oxley Highway (observations). Hastings River alluvial flats. BSAL land. Huntingdon (hn), Long Flat (lf) and Rocks Ferry (rf) soil landscapes. Carboniferous Hastings Block sediments. Beechwood (bw), Dawson (dw), Euroka (eu), Kew (kw) soil landscapes.

Site 3. Beechwood and view of Lorne Basin. The **Lorne Basin** is a small, gently folded and faulted Early Triassic sedimentary basin, contemporary with and equivalent to the Sydney Basin and Clarence-Moreton Basin, forming a roughly circular dissected plateau. Elevations are higher in the west (up to 500 m) and the surfaces generally slope back towards the east. The sedimentary strata gently slope towards the centre, and ridges are often cuesta-like due to differential erosion of the gently dipping strata.

Dominated by the Camden Haven Group and granitoid intrusions, unconformably overlying the Palaeozoic basement (Leitch and Bocking, 1980, revised by Pratt, 2010). Lithology includes red and grey mudstone, lithic sandstone and conglomerate, tuffaceous sandstone, felsic volcanics (rhyolite) and minor coal. The sediments were probably derived from Lower Palaeozoic metasediments further to the west. Because of its circular configuration, Tonkin (1998) suggested that the Lorne Basin might be a Permian-Triassic meteorite impact structure. Soils vary according to substrate lithology from moderately deep and well-structured to shallow, stony, and sodic.

Rollover (ro), Jolly Nose (jn), Lorne (lo) soil landscapes.

Site 4. Riverbreeze Estate, Wauchope. Tertiary terrace with groundwater seepage at contact with bedrock. Planning and land management and implications. Redbank (rb) soil landscape.

Site 5. Cowarra Road and Burrawan Serpentinite outcrop. Palaeozoic serpentinite fault-zone complex, associated with the Sapling Creek Fault that separates the Port Macquarie Block from the Southern Hastings Block. Serpentinite is a hydrated metamorphic ultramafic rock that forms within fault-lines and subduction zones in the upper mantle and basal ocean crust, making its way to the surface by thrust-faulting.

There are significant mineral deposits of nickel, cobalt and scandium in this area (Hedrick, 1997). Soils derived from serpentinites are notoriously infertile the world over, with elevated concentrations of chromium and nickel (Lottermoser, 1997), which may cause toxicity problems to plants (Beadle, 1981, Taylor *et al.*, 1983). These minerals are normally adsorbed to iron oxides at pH above 8, but the field pH observations in this soil landscape are within the threshold for toxicity. In addition, serpentinites are commonly low or lacking in calcium, potassium and phosphorus.

Regolith is shallow stony dark greenish-brown smectite clays, often with strongly cemented nodular ferricrete. The ferricrete is probably a relict Tertiary surface formed by precipitation of iron carried in the groundwater from higher parts of the landscape. The ferricrete pan impedes drainage. Soils are shallow Petroferric Yellow Sodosols and Chromosols (Lateritic Podzolic Soils). Because of the shallow soils and heavy metal toxicities, vegetation are often noticeably distinct from the forest communities on surrounding lithology. Here, *Eucalyptus bancroftii* (orange gum) and *Allocasuarina littoralis* (black she-oak) shrubby woodlands predominate.

Cowarra Access (cs) and Waterloo Road (wd) soil landscapes.

Site 6. Burrawan Forest Dr, Pacific Hwy & Kew Road (observations). Burrawan (ba), Cairncross (ca), Camden Haven (ch), Kew (kw), Lorne (lo), Moorland (ml), The Farm (tf) soil landscapes.

Site 7. North Brother Mountain. Morning tea and views of coast. Coastal granitoid intrusions, late Triassic – early Jurassic, associated with the Hunter-Bowen orogen and the opening up of the Tasman Sea. Includes Three Brothers Mountains, Smoky Cape, Mt Yarrahapinni, Valla. Microgranites and granodiorites. Captain Cook named "the Brothers" on 12 May 1770, unwittingly reflecting the name given to them by the indigenous Birpai people.

Views to the east. Enjoy the views of the coastal development around the lower Camden Haven estuary, including the linear rock training walls, Camden Head, Queens Lake to the northwest and Innes Lake further north.

Views to the south. Watson Taylors Lake, Camden Haven finger delta and Geo-heritage site, Middle & South Brothers, Diamond Head, Crowdy bay NP, Pleistocene inner barrier beach-ridge and sand swamp systems.

Quaternary climatic fluctuations and eustatic sea-level changes had resulted in several large marine transgressions and regressions, with periods of barrier development and estuarine in-filling. The sea-level rise that followed the Pleistocene Glacial periods commenced c. 10,000 years ago and reached its present level c. 6,500 years ago, flooding the coastal lowland plains forming estuarine lakes behind barrier dunes. The Camden Haven River delta is gradually in-filling Queens Lake with alluvium, which will eventually form a setting similar to the lower Manning and Macleay landscapes of levees, floodplains and backswamps which are underlain by acid sulfate soils.

Bird Tree (bi), Crowdy Bay (cy), Pjurrigan (pj), Ghinni Ghinni (gi), Moto Swamp (ms) soil landscapes.

Site 8. Laurieton colluvial fans. Footslopes and pediplains on lower slopes below the North Brothers Mountain. North Brother is subject to high and very intense coastal and orographic rainfall, and gullies are active following intense rainfall. Large colluvial boulders and deeply incised gullies are evidence of destructive long return-period storms at Laurieton. Laurieton has amongst the highest recorded rainfalls in NSW for a 24 hour period. Old colluvial deposits can be destabilised by excavations and re-activated when wet. Urban and infrastructure development which involves constricting runoff in drainage lines and gullies should take serious consideration of significant property damage that can occur under long return-period storm events.

Urban planning & management— I believe a major even is inevitable. Drainage lines and gullies probably should have been retained as drainage reserves, but what now?

Laurieton (la) soil landscape.

Site 9. Dunbogan (observations). Camden Haven estuary, urban development on dunes. Dicks Hill (dh), Dirty Corner (dc), Dunbogan (du), Harrington (ha), Pelican Bay (pb) soil landscapes.

Site 10. Camden Head. Perched dunes, views of coast. Coastal headlands, prior offshore islands now linked by Quaternary sand barriers. Pleistocene transgressive dunes perched on headlands. The dunes were derived from sand blown from the southeast from the exposed sea floor during low sea levels of the glacial maximum 13,000 – 32,000 years b.p. Extreme wind erosion hazards.

Mass movement risks at seepage zones where the sands over-lie bedrock. Soil profile, dune over bedrock. View south to Diamond Head. View west to North Brother and Laurieton. Diamond Head (da), Goolawah (go) soil landscapes.

Site 11. Lake Cathie coastal erosion hotspot. Marvel at the recessive coast where the rates of erosion of sand exceed replenishment. The wave-cut scarp is cut directly into the adjacent Pleistocene sandplain. Benches of diagnostic Pleistocene coffee rock occur at the rear of the beach at Middle Rock at about 1 m a.h.d., indicative of a coastline actively eroding back into the Pleistocene barrier. Extreme coastal erosion risk during high tides and especially during high seas, with risks to roads and urban infrastructure.

Management options— Retreat? Defence? Offshore artificial reef?

Middle Rock (mk), Crowdy Bay (cy) soil landscapes.

Soil landscape summaries

Apanie (ap) Residual

Landscape. Undulating rises with gradients <10%, elevation and relief up to 40 m, on metadolerites. Tall open forests, often cleared for grazing and rural residential development.

Soils. Well drained, stony, shallow to moderately deep, Brown Dermosols (Xanthozems and Brown Earths).

Land & Soil Attributes. Localised shallow soils, stoniness, engineering hazards, neutral to moderate alkalinity, strong structure.

Beechwood (bw) Erosional

Landscape. Undulating – rolling rises and low hills in the lower valley sides in the Ballengarra Hills, on Carboniferous sediments of the Hastings Block. Slopes 5 – 20%, relief 30 – 90 m, elevations 40 – 100 m. Tall open forests, often cleared for grazing.

Soils. Moderately deep, Red Dermosols (Brown Earths or Structured Red Earths) and Brown Dermosols (affinity with Yellow Podzolic Soils).

Land & Soil Attributes. Localised poor drainage, high run-on, seasonal waterlogging, low soil fertility.

Bird Tree (bi) Erosional

Landscape. Rolling low hills and hills on Triassic microgranites. Relief 50 – 200 m, elevation between 10 – 500 m, slopes 25 – 33%. Mostly uncleared tall open forests.

Soils. Moderately well-drained, deep, Yellow Kurosols (Yellow Podzolic Soils), grading to very deep Brown Dermosols (Brown Earths) and Red Dermosols (Structured Red Earths).

Land & Soil Attributes. Localised steep slopes, localised rock outcrop, high erosion risks, localised shallow soils, stoniness, engineering hazards.

Black Bog (bc) Swamp

Landscape. Level backbarrier sandplain swale swamps and deflation surfaces on Pleistocene siliceous sands. Open depressions may have slope about 1%; closed depressions slightly concave or flat. Relief <1 m, elevation 1 – 5 m. Uncleared sedgeland and wet heath.

Soils. Very deep, poorly drained Organosols (Acid Peats) and Humic Aquic Podosols (Humus Podzols and Peaty Podzols).

Land & Soil Attributes. Organic soils, poor drainage, permanently high water tables, groundwater pollution hazard, non-cohesive soils, wind erosion hazard, engineering hazards, low soil fertility, landscape fire hazard.

Burrawan (ba) Residual

Landscape. Gently undulating rises and low hills on Camden Head Claystone (Trch). Relief 10 – 30 m, elevation 5 – 40 m, slopes 3 – 10%. Tall open forests, often cleared for grazing, horticulture and urban development.

Soils. Well-drained, moderately deep, Brown Kurosols (Brown Podzolic Soils) with imperfectly-drained deep to very deep Mottled Yellow Kurosols (Yellow Podzolic Soils) on lower slopes.

Land & Soil Attributes. Hardsetting surfaces, foundation hazard, localised poor drainage, seasonal waterlogging, strong acidity, low soil fertility.

Cairncross (ca) Transferral

Landscape. Narrow open depressions below low hills, grading to broad drainage plains, on slope-wash and valley infill clays and silts. Slopes <4%, relief <2 m, elevation 5 – 10 m. *Eucalyptus tereticornis* and *E. robusta* woodlands and open swamp forests, partly cleared.

Soils. Poorly drained, very deep Mottled Brown or Grey Kurosols (Gleyed Podzolic Soils) and Sodosols (Soloths).

Land & Soil Attributes. High run-on, localised flood hazard, poor drainage, seasonal waterlogging, plasticity, shrink-swell potential, engineering hazards, hardsetting surfaces, sodicity, strong acidity, low soil fertility.

Camden Haven (ch) Alluvial

Landscape. Undifferentiated valley-confined alluvial flats on Quaternary alluvium derived from sediments of the Camden Haven Group. Elevation ranges 3 - 80 m, relief <4 m. Extensively cleared riparian associations.

Soils. Well drained, deep to very deep Red Dermosols (Structured Red Earths), Brown Dermosols (Brown Earths and Xanthozems) and Fluvic Clastic and Stratic Rudosols (Alluvial Soils).

Land & Soil Attributes. Flood hazard, streambank and flood scour hazards, localised high run-on, localised poor drainage, localised seasonal waterlogging, localised non-cohesive soils, groundwater pollution hazard, engineering hazards, strong acidity, high soil fertility, productive agricultural land.

Cowarra Access (cs) Residual/ Transferral

Landscape. Gentle to undulating rises with broad drainage fans on serpentinites. Slopes 3 – 10%, relief up to 10 m, elevation range 10 – 50 m. Partly cleared woodlands.

Soils. Moderately well drained, shallow Bleached Brown Dermosols (aff. Yellow Podzolic Soils) on crests; poorly drained, shallow to moderately deep, Petroferric Yellow Sodosols and Chromosols (Lateritic Podzolic Soils) and Yellow Chromosols (Yellow Podzolic Soils) on lower slopes.

Land & Soil Attributes. Localised rock outcrop, localised high run-on, localised poor drainage, seasonal waterlogging, plasticity, shrink-swell potential, shallow soils, stoniness, localised non-cohesive soils, engineering hazards, sodicity, hardsetting surfaces, strong acidity, low soil fertility.

Crowdy Bay (cy) Aeolian

Landscape. Low inner-barrier beach-ridge plain on Pleistocene back-barrier sand. Local relief 1 – 2 m, elevation 2 – 10 m, slopes < 3%. Complexes of mallee woodlands, wallum shrublands and sedgelands; occasionally cleared for residential development and sand mining.

Soils. Very deep, rapidly drained Aeric Podosols (Podzols), with poorly-drained Humic Aquic Podosols (Humus Podzols) in swales.

Land & Soil Attributes. Wind erosion hazard, rapid drainage, localised poor drainage, localised seasonal waterlogging, groundwater pollution hazard, non-cohesive soils, localised engineering hazards, low moisture availability, low soil fertility, landscape fire hazard.

Dawson (dw) Erosional

Landscape. Rolling low hills on lithic sandstones of the Hastings Block in the Lorne Dissected Plateau and Kempsey – Forster Low Hills. Slopes 20 – 33%, local relief 20 – 90 m, elevation range 10 – 200 m. Dry sclerophyll forests and woodlands, partly cleared.

Soils. Moderately well drained shallow – moderately deep Haplic Brown Kurosols (Brown Podzolic Soils) and occasional Inceptic/Lithic Orthic Tenosols (Lithosols), with imperfectly drained 65 – 95 cm Red Dermosols (structured Red Earths) sheltered on lower slopes.

Land & Soil Attributes. Localised steep slopes, high erosion risk, localised shallow soils, stoniness, engineering hazards, hardsetting surfaces, strong acidity, infertile soils.

Diamond Head (da) Erosional

Landscape. Rolling low hills on isolated coastal headlands, on various rock types. Slope range generally 20 – 33%, elevation and relief up to 80 m. Coastal headland complex, sometimes cleared for housing.

Landscape Variant daa. Colluvial variant. Steep to precipitous low hills, sea cliffs, slopes 33% to over 100%.

Soils. Imperfectly drained, moderately deep, Mottled Yellow Kurosols (Yellow Podzolic Soils and Soloths), with shallow Leptic Tenosols (Lithosols and Black Headland Soils) and exposed rock faces on steep slopes.

Land & Soil Attributes. Localised steep slopes, localised rock outcrop, mass movement and rock fall hazards, high erosion risk, localised poor drainage and seasonal waterlogging, localised shallow soils, stoniness, engineering hazards, hardsetting surfaces, strong acidity, low soil fertility.

Dicks Hill (dh) Aeolian

Landscape. Pleistocene transgressive dunes perched on headlands. Rolling to steep hills, with slopes 10 – 50%, and elevation and relief up to 50 m. Gently undulating rises & low hills. Elevation and relief 10 – 50 m. Low open forests and woodlands, sometimes cleared.

Soils. Very deep, rapidly drained Aeric Podosols (Giant Podzols) overlying buried terrestrial clays.

Land & Soil Attributes. Localised steep slopes, severe wind erosion hazard, localised mass movement hazard, sand mobilisation hazard, rapid drainage, groundwater pollution hazard, non-cohesive soils, engineering hazards, low moisture availability, low soil fertility.

Dirty Corner (dc) Swamp

Landscape. Level backbarrier and inter-barrier closed depressions, on Pleistocene clayey sands overlain by peats and estuarine deposits. Relief <1 m, elevation <5 m, slopes <1%. Swamp sclerophyll forests.

Soils. Poorly drained, very deep, Organosols (Acid Peats), Peaty Hydrosols (Humic Gleys) and Aquic Podosols (Peaty Podzols) overlying Pleistocene sands.

Land & Soil Attributes. Poor drainage, flood hazard, seasonal waterlogging, permanently high water tables, groundwater pollution hazard, engineering hazards, localised salinity, acid sulfate soils risk, organic soils, strong acidity, low soil fertility, soil fire hazard.

Dunbogan (du) Aeolian

Landscape. Pleistocene barrier dunes and transgressive dunes on barrier sands. Gently undulating rises & low hills. Slopes mostly 3 – 10%. Elevation and relief up to 12 m. Low open forests, mostly cleared.

Soils. Very deep, rapidly drained Arenic Rudosols (Siliceous Sands) and Aeris Podzols (Giant Podzols).

Land & Soil Attributes. Wind erosion hazard, sand mobilisation hazard, rapid drainage, groundwater pollution hazard, non-cohesive soils, low moisture availability, low soil fertility.

Euroka (eu) Erosional

Landscape. Rolling low hills on Carboniferous sediments of the Hastings Block. Relief 20 – 60 m, elevation 20 – 90 m, slopes generally 10 – 25%. Open dry sclerophyll forests, partly cleared.

Soils. Imperfectly drained, moderately deep, Red, Yellow and Brown Kurosols (Red and Yellow Podzolic Soils), with Red and Brown Dermosols (Krasnozems and Prairie Soils).

Land & Soil Attributes. High run-on, erosion hazard, localised poor drainage, seasonal waterlogging, engineering hazards, hardsetting surfaces, strong acidity, low soil fertility.

Ghinni Ghinni (gi) Alluvial

Landscape. Narrow gently undulating plains; alluvial levees of the lower Manning, Lansdowne and Camden Haven fluvial-deltaic plains. Slopes 2 – 4% on plains and upper surfaces, to 50% on river banks, local relief <3 m, elevation <10 m. Subtropical rainforests, woodlands (mostly cleared) and gallery mangroves.

Soils. Very deep, well-drained Brown Kandosols (Alluvial Soils and Prairie Soils), grading to imperfectly drained Kandosolic Hydrosols (Alluvial Soils) and Sulfidic Hydrosols (Humic Gleys).

Land & Soil Attributes. Localised flood hazard, streambank erosion hazard, localised poor drainage, localised seasonal waterlogging, groundwater pollution hazard, localised non-cohesive soils, plasticity, localised acid sulfate soils risk, localised engineering hazards, high soil fertility, prime agricultural land.

Goolawah (go) Beach

Landscape. Ocean beaches and associated foredunes on Holocene outer barrier sands. Beaches elevation and relief <3 m and slopes <5%; dunes relief <15 m and slopes 20 – 60%. Low coastal shrublands on dunes.

Soils. Very deep, rapidly drained Shelly Rudosols (Siliceous Sands) on beaches, and Arenic Rudosols (Siliceous Sands) and weakly developed Aeris Podzols (Podzols) on dunes.

Land & Soil Attributes. Complex terrain, coastal erosion, wind erosion and sand mobilisation hazards, localised steep slopes and mass movement hazard, rapid drainage, non-cohesive soils, very low moisture availability, low fertility.

Harrington (ha) Aeolian

Landscape. Level backbarrier sandplains on Pleistocene clayey sands with seasonally high water tables. Local relief <1 m, elevation 1 – 2 m, slopes < 3%. Open (dry sclerophyll) forests, occasionally cleared.

Soils. Very deep, imperfectly drained Semiaquic and Aquic Podzols (Humus Podzols).

Land & Soil Attributes. Wind erosion hazard, poor drainage, localised rapid drainage, seasonal waterlogging, groundwater pollution hazard, non-cohesive soils, localised engineering hazards, low moisture availability, localised acid sulfate soils, strong acidity, low soil fertility, landscape fire hazard.

Huntingdon (hn) Alluvial

Landscape. Intermediate-level terrace plains of the middle reaches of the Hastings River. Slopes 1 – 5%, local relief 4 – 8 m, elevations 10 – 30 m. Extensively cleared riparian forests.

Soils. Very deep, well drained Brown Dermosols (Prairie Soils) and Brown Chromosols/ Kurosols (Brown Podzolic Soils), with poorly drained Redoxic Hydrosols (Grey Clays) in swales.

Land & Soil Attributes. Localised high run-on, localised streambank erosion hazard, minor wind erosion hazard, localised poor drainage, localised seasonal waterlogging, foundation hazard, groundwater pollution hazard, high erodibility, high soil fertility, productive agricultural land.

Jolly Nose (jn) Colluvial

Landscape. Steep to very steep hills on Triassic conglomerates of the Lorne Dissected Plateau. Slopes 30 – 60%, local relief 90 – 300 m, elevation 50 – 600 m. Uncleared tall open forests.

Soils. Well drained, shallow – moderately deep, Inceptic Tenosols and Leptic/ Clastic Rudosols (Lithosols and Earthy Sands), Yellow Chromosols (Yellow Podzolic Soils), Yellow Kandosols (Yellow Earths), and Brown Dermosols/ Kurosols (Brown Earths, Structured Red Earths, Red Podzolic Soils).

Land & Soil Attributes. Steep slopes, very high erosion risk, mass movement hazard, localised rock outcrop, shallow soils, stoniness, localised non-cohesive soils, engineering hazards, strong acidity, low soil fertility.

Kew (kw) Residual

Landscape. Undulating rises on Devonian – Carboniferous sediments of the Hastings Block in the Kempsey-Myall Low Hills. Slopes 3 – 10%, local relief 10 – 20 m, elevation 5 – 30 m. Open forests, mostly cleared.

Soils. Shallow to moderately deep, imperfectly drained Yellow Kurosols (Yellow Podzolic Soils) and moderately deep to deep, poorly drained Mottled Yellow Kurosols (Gleyed Podzolic Soils and Soloths).

Land & Soil Attributes. Localised poor drainage, seasonal waterlogging, localised shallow soils, engineering hazards, hardsetting surfaces, strong acidity, low soil fertility.

Laurieton (la) Transferral

Landscape. Undulating plains and rises; footslopes, fans and pediplains on colluvium derived from microgranites and conglomerates. Slope range 3 – 15% (mostly 5 – 10%), relief 10 – 30 m, elevation range 5– 200 m. Tall open forests and woodlands, often cleared.

Soils. Moderately well drained, deep to very deep, Red Kurosols/Chromosols (Red Podzolic Soils) on ridges; imperfectly drained, deep Brown or Yellow Kurosols (Brown or Yellow Podzolic Soils) on footslopes; imperfectly drained, deep Fluvic Clastic Rudosols (Alluvial Soils) on fans.

Land & Soil Attributes. High run-on, high erosion risk, colluvial deposition hazard, seasonal waterlogging, localised stoniness, localised non-cohesive soils, engineering hazards, strong acidity, low soil fertility.

Long Flat (lf) Alluvial

Landscape. Narrow valley-confined discontinuous inset floodplains of the Hastings River and tributaries on Holocene alluvium. Relief <3 m, elevation range 90 – 200 m. Mainly cleared riparian complex.

Soils. Well drained, very deep, Brown Kandosols and Dermosols (Prairie Soils) and shallow to deep Fluvic Clastic and Stratic Rudosols (Alluvial Soils).

Land & Soil Attributes. Localised streambank and flood scour hazards, localised poor drainage, localised high run-on, flood hazard, localised seasonal waterlogging, groundwater pollution hazard, engineering hazards, strong acidity, high soil fertility, productive agricultural land.

Lorne (lo) Erosional

Landscape. Rolling hills of the Lorne Dissected Plateau on Triassic Camden Head Claystone (Trch). Slopes 20 – 33%, local relief 50 – 200 m, elevation 10 – 500 m. Tall open forests, often cleared.

Soils. Moderately well drained, moderately deep to deep, catenary sequences of Brown and Yellow Kurosols/ Dermosols (Brown/ Yellow Podzolic Soils).

Land & Soil Attributes. Localised steep slopes, high erosion risk, stoniness, engineering hazards, hard-setting surfaces, strong acidity.

Middle Rock (mk) Beach

Landscape. Ocean beaches on Holocene outer barrier sands; recessive coast with narrow eroding beaches. Beaches with elevation and relief <3 m and slopes <5%; dunes with relief 4 – 6 m and slopes 20 – 60%. Complex of shrublands with bare sand on beaches.

Soils. Very deep, rapidly drained deep Aeric Podosols (Podzols).

Land & Soil Attributes. Extreme coastal erosion hazards, wind erosion hazard, localised steep slopes and mass movement hazard, rock outcrop, rapid drainage, non-cohesive soils, engineering hazards, low moisture availability, low soil fertility.

Moorland (ml) Residual

Landscape. Gently undulating rises on the Triassic Camden Head Claystone (Trch). Slopes 3 – 10%, local relief 3 – 9 m, elevation 10 – 50 m. Extensively cleared tall open forests.

Soils. Very deep, well drained, Red Dermosols (Structured Red Earths, Krasnozems).

Land & Soil Attributes. Deep soils, low wet bearing strength, localised stoniness, localised seasonal waterlogging, strong acidity, high soil fertility, productive arable land.

Moripo (mo) Erosional

Landscape. Rolling low hills on metadolerites and dacites. Slopes generally 25 – 33%, elevation and relief up to 150 m. Tall open forests, often cleared for grazing and rural residential development.

Landscape variant moa. Slopes 10-25%.

Soils. Moderately well drained, stony, moderately deep, Brown and Yellow Dermosols (Prairie Soils, Xanthozems, and soils similar to Yellow or Brown Earths) and Brown Chromosols (Yellow Podzolic Soils).

Land & Soil Attributes. Localised steep slopes, high erosion risk, localised shallow soils, localised seasonal waterlogging, stoniness, engineering hazards, neutral to moderate alkalinity.

Moto Swamp (ms) Estuarine

Landscape. Extensive estuarine flood-basins and deltaic backswamps of the lower Manning and Lansdowne River deltas. Extremely low relief and low elevation (<1 m). Often extensively drained. Wet meadow and sedgeland fringed by swamp sclerophyll forests.

Soils. Very deep, very poorly drained, Sulfidic/Sulfuric Hydrosols (Humic Gleys).

Land & Soil Attributes. Poor drainage, flood hazard, permanently high water tables, wind erosion hazard, acid sulfate soils risk, strong acidity, engineering hazards, organic soils.

Pelican Bay (pb) Estuarine

Landscape. Level intertidal and supratidal flats in coastal inlets and estuaries on Holocene estuarine sediments. Elevation <2 m. Estuarine complex of mangroves, saltmarsh and swamp sclerophyll forests.

Soils. Very deep, waterlogged, Sulfidic Intertidal and Supratidal Hydrosols (Solonchaks and Humic Gleys) on muddy sediments, with Arenaceous Intertidal Hydrosols (Siliceous Sands) on sand flats.

Land & Soil Attributes. Tidal flood hazard, streambank erosion hazard, poor drainage, permanently high water tables, localised non-cohesive soils, high erodibility, acid sulfate soils risk, engineering hazards, salinity.

Pjurrgan (pj) Colluvial

Landscape. Steep hills and mountains on Triassic microgranites. Local relief 90 – 500 m, elevation between 20 – 560 m, slopes 33–60%. Mostly uncleared tall open forests.

Soils. Well-drained, stony, shallow to moderately deep Orthic and Chernic Tenosols (Lithosols), grading to moderately deep to deep Red and Brown Kurosols (Red and Yellow Podzolic Soils) and Red Dermosols (Structured Red Earths).

Land & Soil Attributes. Steep slopes, rock outcrop, erosion, mass movement and rock fall hazards, localised shallow soils, stoniness, engineering hazards, localised low moisture availability, strong acidity.

Redbank (rb) Residual

Landscape. Gently undulating Tertiary high terraces on mid to lower reaches of the Hastings River. Slopes 1 – 10%, local relief 2 – 4 m, elevation range 10 – 60 m. Extensively cleared open forests.

Soils. Very deep, well drained Red Dermosols/ Kandosols (Red Earths).

Land & Soil Attributes. Localised high run-on, localised seasonal waterlogging, engineering hazard, groundwater pollution hazard, acidity, high soil fertility, productive arable land.

Rocks Ferry (rf) Alluvial

Landscape. Low undulating rises and swales on the floodplain of the upper estuarine reaches of the Hastings River. Elevations range from 3 – 10 m and relief < 4 m. Completely cleared.

Soils. Very deep, well drained Brown Dermosols (Euchrozems) and Brown Kandosols (Alluvial Soils).

Land & Soil Attributes. Localised flood hazard, localised high run-on, localised streambank erosion hazard, localised seasonal waterlogging, engineering hazards, high soil fertility, productive agricultural land.

Rollover (ro) Vestigial

Landscape. Precipitous cliffed upper slopes of the Lorne Dissected Plateau on Triassic conglomerates. Slopes 60% to vertical, local relief 90 – 150 m, elevation 130 – 600 m. Shrublands and low woodlands.

Soils. Well drained, shallow, Leptic Tenosols (Lithosols) and Clastic Rudosols (Siliceous Sands).

Land & Soil Attributes. Precipitous slopes, extreme erosion and mass movement hazards, rock outcrop, rock fall hazard, shallow soils, stoniness, non-cohesive soils, engineering hazards, strong acidity.

Sea Acres (sa) Erosional

Landscape. Rolling rises and low hills on mafic metasediments and sediments. Relief 10 – 50 m, elevation 10 – 60 m, slopes 10 – 25%. Tall open forests and subtropical rainforests, mainly cleared for urban development.

Soils. Deep to very deep, well drained Red Ferrosols (Krasnozems).

Land & Soil Attributes. Erosion hazard, localised stoniness, strong structure, strong acidity, high soil fertility.

The Farm (tf) Erosional

Landscape. Undulating to rolling low hills as lower slopes in the Lorne Dissected Plateau on the Triassic acid volcanics and sediments of the Lorne Basin. Relief 20 – 90 m, elevation 10 – 200 m, slopes 10 – 20%. Partly cleared open forests.

Soils. Moderately well drained, deep Red/ Brown Kurosols (Red Podzolic Soils) and moderately to very deep, poorly drained, Mottled Natric Yellow/ Brown Kurosols (Soloths).

Land & Soil Attributes. High run-on, erosion hazards, localised poor drainage, seasonal waterlogging, low wet bearing strength, engineering hazards, hardsetting surfaces, strong acidity, low soil fertility.

Thrumster (th) Residual

Landscape. Undulating to rolling rises and low hills, on mafic metasediments and sediments. Relief 10 – 50 m, elevation 10 – 60 m, slopes 3 – 10%. Tall open forests and rainforests, extensively cleared.

Soils. Very deep, well drained Red Ferrosols (Krasnozems), with imperfectly drained Mottled Brown Kurosols (Lateritic and Brown Podzolic Soils) on lower slopes.

Land & Soil Attributes. Deep soils, low wet bearing strength, localised stoniness, localised seasonal waterlogging, strong acidity, high soil fertility, productive arable land.

Waterloo Road (wd) Erosional

Landscape. Rolling rises and low hills on serpentinites. Slopes 10 – 25%, local relief 20 – 40 m, elevation range 10 – 80 m. Uncleared Eucalyptus resinifera and E. bancroftii woodlands with shrubby understoreys.

Soils. Complex of shallow to moderately deep moderately well drained Black Vertosols (Black Earths) and Brown Vertosols (Chocolate Soils) and very shallow Lithic Leptic Tenosols (Lithosols).

Land & Soil Attributes. Rock outcrop, localised poor drainage, shallow soils, stoniness, high plasticity, high shrink-swell potential, engineering hazards, complex soils, low soil fertility.