

Introductory Address by A.F. Shirley to

WATER RESEARCH FOUNDATION WORKSHOP ON
UNSTABLE LANDFORMS - 2ND JULY, 1976.

My task here today is to introduce the subject of "Unstable Land" to you by giving an appraisal of:

- what we mean by "unstable", and the "Risk of Failure".
- the various types and extent of unstable landforms in this state.
- the problem that this instability can present.

The basic problem about the word "unstable" is that people seem to think that unstable means unusual. In a Readers Digest Book on words you will find that:-

"unstable emphasises impermanence, suggesting a foundation that is capable of changing or shifting".

There are therefore, very few things in this world that are not unstable, e.g. our political situation, or our own life style. However, we all have the habit of thinking that "it can never happen to me", and that disaster cannot or will not, fall.

We should also recognise that failures are often the result of an unstable situation. Failures are not usually "acts of God" because, in every design there is an implicit, if unrecognised, "Risk of Failure". The average person does not generally recognise the concept of "Risk of Failure". Generally the public expects technical people to build structures that are completely safe. For example, the normal person travelling across the Sydney Harbour Bridge does not imagine that the bridge can collapse. However, bridges do collapse. Some Australian examples of bridges that have collapsed are:

The King Street Bridge.

The Westgate Bridge.

and, Sydneysiders will remember the partial failures of the:

The Hawkesbury River Rail Bridge.

The Tarban Creek Bridge.

There are also lots of overseas examples.

Although it is understandable that the public (and their elected or appointed Administrators) has difficulty in understanding the "Risk of Failure" concept, it is surprising how many of those involved in design have only vague ideas about it. Technical people are often unaware of the implications of their design decisions upon the structure performance.

The acceptable "Risk of Failure" is largely a function of the particular structure being designed or built. It is clearly undesirable for a major bridge to collapse, whereas we don't usually get upset when a few cracks appears in a bitumen road after 10 years. We also accept failure in many other structures (e.g. stormwater pipes etc.), provided that human life is not endangered. Failure is a normal concept of design, and we must accept it whether we like it or not. Remember a stormwater pipe system is 'designed to fail', every 5, 10 or 20 years depending upon its location.

Bearing in mind these remarks, what are the failures occasioned by "unstable land" where do they occur, and how do they affect people?

THE LOCAL FAILURE SCENE

Looking around N.S.W., failures of many and varied types are occurring. The "Hillside" type of unstable land failures at Newport, Avalon and Bulli are probably all well known to you, however how many of you are aware of unstable land failures in places like:

- Picton, Bowral.
- Dorrigo, Coffs Harbour, Bellingen.
- Kempsey, Macksville.
- Warners Bay, Charlestown, Merewether Heights.
- Tamworth, Guyra.
- Penrith, Springwood, Castlereagh.
- Nowra, Berry, Bega.

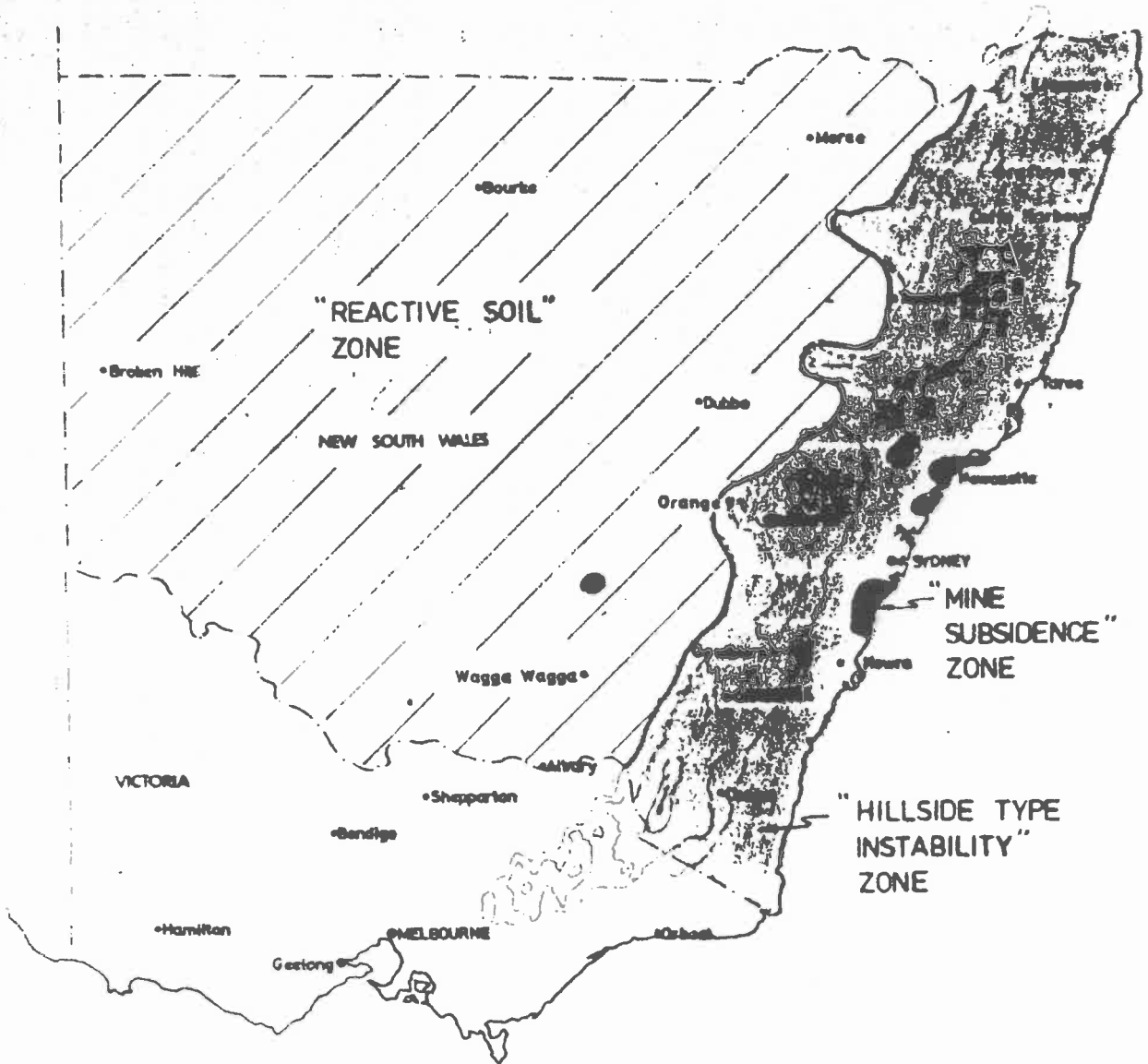
and the list can go on and on.

All of the previously mentioned places have significant areas of landslip, have had houses, retaining walls, roads etc. failing directly as a result of landslip which is only one variety of unstable land. For the purpose of discussion I have divided unstable landforms into four categories:

- Hillside or Sloping Land.
- Filled Ground.
- Mine Subsidence.
- Reactive Soils.

I've had prepared a map of this state which shows the potential areas of problem due to the various types of instability mentioned above. This map does not purport in any way to be accurate or detailed, however it does indicate that:-

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- instability of various types can be expected throughout the whole of N.S.W.
- Unstable land is not confined to the Wollongong and Illawarra districts.
- There are a large number of problems associated with building wherever you go within N.S.W.

Of course Hillside Building problems do not occur over the total area indicated, however we should not be surprised if we encounter land stability problems in this area.

UNSTABLE LANDFORM PROBLEMS

Referring now to the previous division of unstable land, I propose to discuss the problems that occur under each heading.

1. Hillside or Sloping Land Problems

Broadly speaking most of these problems are related to the necessity to live on "flat-ground". Consequently, when building on a hillside we move the ground around so that the area where we want to live is level, and in undertaking this work we often create an unstable situation that I have termed "Hillside Instability". The problems presented by sloping land development are therefore:

Suburban Houses

CARS	Car access and driveways. Where to park cars? How to take advantage of the view? What rooms should be planned at street level? Where do the children play - danger? How to plan outdoor living on a mountain goat site? Swimming pools - how and where? Privacy. Neighbours drainage and fences.
GARDENS	What plants would thrive on the slope? What can be done to prevent or alleviate erosion? Garden walls - what type? Garden sheds and outbuildings.
SERVICES	Water, Gas and Electricity - how to get services there? Sewer design is very difficult.
HOUSE STRUCTURE	Rigid or flexible? Heavy or lightweight? Can we live with a flexible house? Bush fire control.

Roads

FORMATION	Adjustment of Geometry (including road width) to suit topography. Cut and fill can create instability. Crossing of creeks - How? Do we block up an an underground water path if we fill the creek? Stormwater drains are designed to fail. Do we need a system for the overload storm-water? Minor - major drainage system concept.
SERVICES	Placement in footpaths which may not be stable. Difficulty of united approach by public authorities. How do you repair damaged services?
RAILWAYS	Tunnels often required. Large cuts and fills, that may become unstable. Track maintenance can be difficult.

2. Filled Ground Problems

The problem I have called "Filled Ground Problems" are generally related to the settlement of the filling, and it is this settlement that causes the structural damage. One of the major problems related to filled ground is the identification of the filled area. Too many areas of filled ground are simply not delineated on any plan at all, and therefore are a real trap for the unwary. Many councils have tried to overcome the problems of settlement on private property by requiring "Certificates of Compaction". However, these certificates may not always be reliable. If we really want to ensure satisfactory compaction, then there is really no substitute for the Council employing the supervisory staff itself. Further, many local councils only have compaction requirements under road areas, and none for the filling of private land. Consequently filling upon private land is often very poorly placed and compacted.

The problems caused by "Filled Ground" can therefore be summarised as:

FILLED GROUND PROBLEMS

Roads and Railways

Cracking and displacement of kerb and gutter.
Ponding of water in gutters.
Cracking and settlement of storm-water pipes.
General damage to services.
Distress and possible failure of pavements.

Houses

Cracking of brickwork and plaster.
Large settlements can cause water to flow into houses.
More expensive foundations as an Engineer generally required for investigation and design.
Landscaping often difficult - plants don't like sandstone fill or salt water.

3. Mine Subsidence

Because of the serious nature of mine subsidence, there has been set up a statutory authority called the "Mine Subsidence Board" to look after it. As a result, anything that you do in a Mine Subsidence District is subject to the control of the Board, and prior to undertaking any development you must submit your plans and specifications to the Board for approval.

Briefly, the problems that relate to Mine Subsidence are:

MINE SUBSIDENCE PROBLEMS

Houses

Mine Subsidence Board approval required.
Often expensive foundations.
Drainage problems.
Differential settlement.

Roads and Railways

Large settlement - potholes.
Land instability.
Potential for catastrophic failure of road fills.
Large amount of maintenance often required.

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4. Reactive Soil Problems

In simplest terms, reactive soil problems occur wherever the soil upon which you would like to build moves up and down as the weather changes. The problem is largely one of unsaturated soils, and too vast to enter into here. We should recognise however that a structure designed to be built in a "Reactive Soil Area" must take into account the characteristics of reactive soils, or otherwise we can expect cracking and other signs of failure in our structures.

PLANNING

Professor Ingles in his paper has alluded to the need to develop a Building Code for Unstable Areas. I would like to echo his sentiments because a lot of the problems that have arisen in the past, have been caused by:

- the preparation of subdivisional plans and the undertaking of roadworks with little, or no regard, for the Geological conditions of the site.
- the construction of inadequate physical access to individual sites.
- the construction of housing types unsuited to hill-side development.
- inadequate drainage systems for both public roads and private dwellings.

It seems to me that we also have a problem in the isolation and delineation of unstable areas. I would think that we must develop a Planning process that enables potentially unstable areas to be isolated and subjected to stringent development requirements. Unfortunately however many local councils tend to ignore the question of "Unstable Land", and hope that the problem will simply go away. A planning process that incorporates identification of these areas must therefore be developed, however we must recognise that what works in an unstable situation in Gosford may not work in Wollongong. Each geographic area has its own distinct problems, and will usually therefore have a unique solution. The detailed planning must as a consequence be at the local level, although the overall planning may well be at the State level.

It appears to me that it would help if future Development Applications submitted in Hillside Areas were based on an Engineering and Geological report, which included statements and information upon:-

- the state of natural stability of the site.
- an appraisal of how the development will affect the natural stability of the site.
- the technical data on which the stability assessments have been based.

Concluding with the following remarks.

- 1) Unstable land occurs over large areas of this state.
- 2) There are many problems, but very few that cannot be solved by careful application of currently available scientific methods.
- 3) There is always a risk of failure in everything we do, and we should be aware of this risk, and ensure that the people that consult us are also aware of the risk.
- 4) Building codes can and should be developed. But the codes should be specific and relevant to a fairly small geographic area.
- 5) Responsibility for precise delineation of the "Problem Area" should rest with the Local Council. This could be achieved by selectively calling for appropriate Geological Reports prior to approval for development applications.