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The Department of Primary
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Erosion and Landslide Case Studies For the CCMA Region

Supporting Document to the
Corangamite Soil Health Strategy

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1. Introduction

The Corangamite Catchment Management Authority (CCMA) has developed the Corangamite Soil Health Strategy (CSHS) as a sub strategy of the Corangamite Regional Catchment Strategy (CRCS). The CSHS links to state and federal frameworks and aims to compliment other sub strategies under the CRCS. This will allow an integrated approach to the protection of key assets identified under this and other sub-strategies.

The CSHS addresses a diverse range of soil health issues and will provide the basis for investment in regional soil health over the coming years. As such, a key aim of the CSHS is to assist the CCMA and other stakeholders in guiding investment to protect and enhance assets in the region that are at risk from threatening processes associated with soil health.

The CSHS uses a relative risk to asset based approach to identify priority areas where soil threatening processes are impacting important assets. The process considered 12 different soil threatening processes in 15 sub catchment or landscape zones. By superimposing the distribution of 5 primary assets classes with these threats, a series of risk to assets combinations were evaluated and the top 20 combinations of threats, assets and landscape zones were chosen as the initial priority zones for the CSHS.

The resulting top 20 priority zones contained 15 combinations including threats of landslides or erosion, emphasizing the importance of these soil threats within the CCMA region. As a result much of the initial research and focus has been placed on landslide and erosion in the early phases of the CSHS.

This report introduces the concepts of the risk based approach undertaken in the CSHS project and highlights the importance of information on impacts to assets and the associated consequences. The report then discusses the development of a series of case studies throughout the CCMA to provide further information on consequence of erosion and landslides on highly valued assets.

2. Background and Aims.

The Corangamite Soil Health Strategy (CSHS) has adopted a relative risk to asset based approach to help identify priority area where different soil threatening processes pose the greatest risk to highly valued assets.

The risk approach involves answering the following questions:

- What might happen? (Assess the likely modes of land degradation).
- How likely is it? (Assess the probability of occurrence).
- What impact, damage or injury may result? (Assess the consequence of the hazard).
- How important is it? (Assess the significance of the impact in relation to the regulatory criteria and public opinion).
- What can be done about it? (Assess treatment options including management and mitigation options).

After an initial hazard identification phase, the process involves the estimation of both likelihood and the consequence of occurrence. The combination of these two elements provides an estimation of the level of risk i.e.

Risk=Function (Likelihood and Consequence).

In order to facilitate the risk process, information regarding the extent and distribution of threats (or hazards) such as erosion and landslides is needed as well as information on assets. The interaction between threats and assets has then undertaken using GIS methods and risk is estimated based on the severity and significance of the impact on the asset.

The key steps in any risk based approach are as follows:

- Collation of information on various factors which may have an influence on the presence and/or the initiation of the hazard under study. Such factors are sometimes described as preparatory casual factors and triggering causal factors (*factor mapping*)
- Assembly of information on the hazard under study (*data inventory*)
- Collation of this information into spatial coordinates (*inventory mapping*)

This information can then be further used to identify hazards through a modelling process. The combination of the preparatory and triggering factors with the known distribution of the hazard can be used to establish areas of actual and possible (or likely) occurrence. This is also known as susceptibility (*susceptibility mapping*)

Another important part of the risk based approach is the determination of how severe an asset is impacted and how important or significant the impact is. This is usually termed *consequence analysis*.

The current 2006/2007 program for the Corangamite Soil Health Strategy (CSHS) recognised the need for such information and a series of case studies were commissioned to provide specific data on the nature, extent and impact of erosion and landslides at various important locations throughout the CCMA region.

The aim of the case studies was to provide more detailed information on the extent of the hazard, how it was initially assessed and what remedial actions were either undertaken or proposed. In addition the case studies review what assets were effected, how severe the impact was and what consequences and financial costs were associated with effected assets.

3. Scope of Commission.

As a result, A.S. Miner Geotechnical was commissioned to undertake a series of case studies throughout the CCMA region to assist with the assessment of the consequences and impacts of erosion and landslides on valued assets. The following tasks were included:

- Select sites and locations for case studies highlighting both erosion and landslides in a wide range of landscape zones within the CCMA region.
- Establish a template for recording and documentation
- Gather further information on the nature of the hazard including dates of first activation, dates of reactivations, extent, and rate of occurrence.
- Assess the nature and value of the assets under threat
- Assess the consequences and impact of the hazard with respect to the assets under threat or the elements at risk.
- Document remedial works already undertaken or describe remedial works which might be suitable to assist in reducing or mitigating the effects of the hazard.
- Document costs and impacts associated with the hazard or threat through loss of assets and the required works.
- Describe the nature and the costs of future monitoring and review programs.

This report describes the task as described above, lists the sites assessed and details recommendations for future work.

4. Selection of Sites.

Sites for case studies were chosen to correspond, where possible, with locations and sites established as priority target areas during the early stages of the 2006/2007 CSHS program. These target areas were identified through a GIS based desk top study and were further assessed in the field by members of the soil health team during late 2006. Further information on the selection of the priority target areas can be found in the following reports:

- “Field Verification of Relative Risk to Asset Rankings for Erosion and Landslides in Landscape Zones in the CCMA”. Report No 352/01/06. Dated 14th September 2006. prepared by A.S. Miner Geotechnical

Figure 1 shows the locations of priority target areas for erosion and landslides throughout the CCMA.

A series of 44 sites containing important assets and known incidences of landslide and erosion were initially chosen and these were further reduced based on the amount of available information, timeframes for site inspections and other budgets restraints. The full list of initial sites is shown in Table 1 whilst those sites chosen for case studies are highlighted within the table.

It is envisaged that other sites will be added to this list in the future while further case studies on the list above will be completed in ongoing programs of the CSHS.

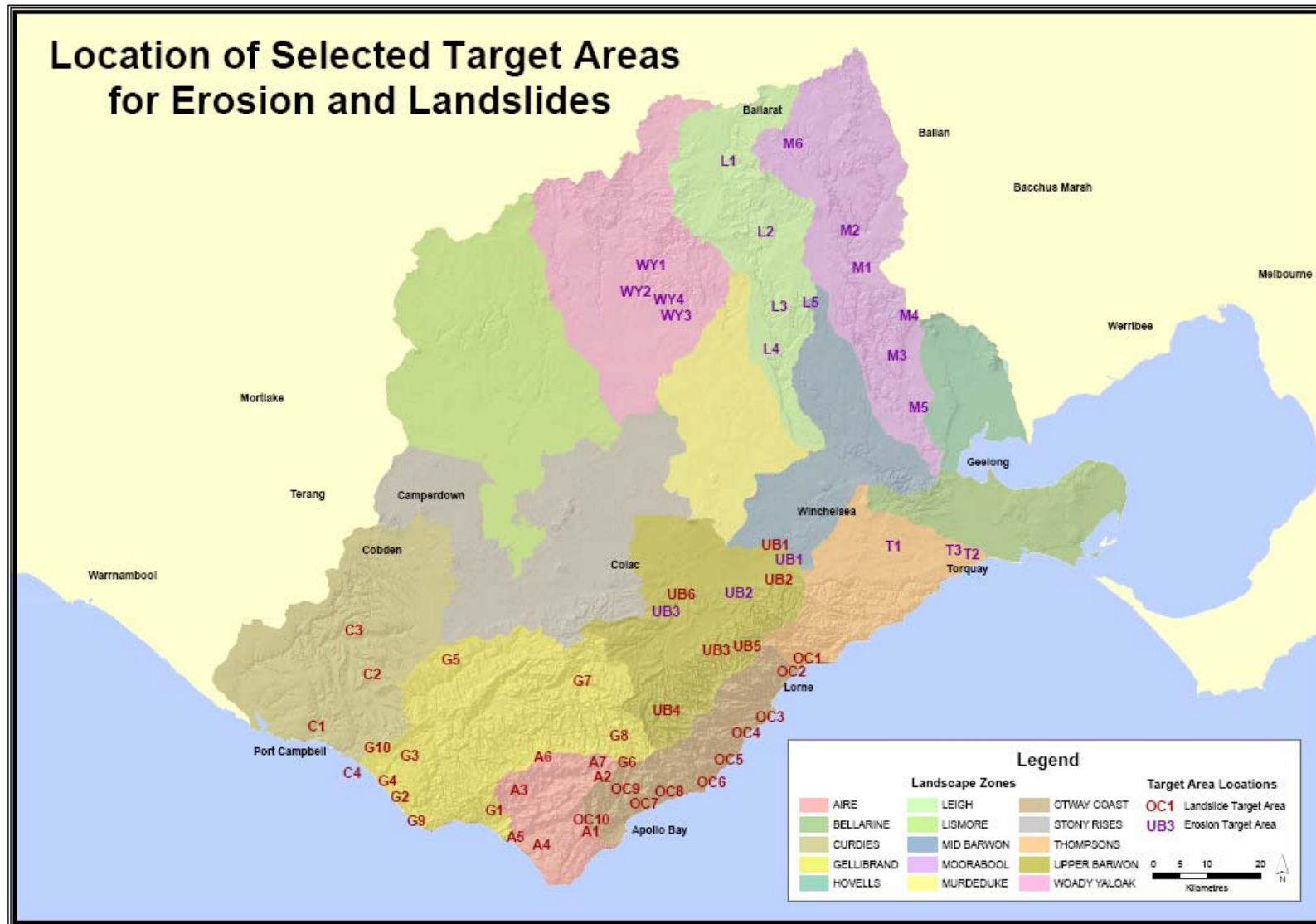


Figure 1 Location of Selected Priority Target Areas in the CCMA Region

ID	Type	Location	Status	Shire	Landscape Zone	Date of	Assets at Risk
356.3/01	Landslide	Barham Valley Rd Apollo Bay	Completed	Colac Otway	Otway Coast	1986	Grazing land, infrastructure
356.3/02	Gully	Rokewood-Skipton Rd Plitfield	Completed	Golden Plains	Woody Yallock	NA	Ag land
356.3/03	Landslide	Princetown-Simpson Rd Princetown (Bouwman's)	Completed	Corangamite	Gellibrand	1978	House and dairy land
356.3/04	Landslide	Western Freeway Bacchus Marsh	Completed	Moorabool	Outside CCMA	2006	Road and users
356.3/05	Landslide	Great Ocean Rd (Windy Point)	Completed	Surfcoast	Otway Coast	1970	Road
356.3/06	Landslide	Yeodene-Birregurra Rd Birregurra (Phillips)	Completed	Colac Otway	Upper Barwon	1964	Waterway
356.3/07	Tunnel Erosion	Separation Creek	not started	Colac Otway	Otway Coast	NA	House
356.3/08	Tunnel Erosion	Kennett River	not started	Colac Otway	Otway Coast	NA	House
356.3/09	Tunnel Erosion	Deans Marsh-Lorne Rd, Deans Marsh	not started	Surfcoast	Upper Barwon	NA	Road
356.3/10	Landslide	Great Ocean Rd Wongarra	not started	Colac Otway	Otway Coast	Oct-2000	Road
356.3/11	Landslide	Wild Dog Ck Rd, Apollo Bay (Big Slide)	not started	Colac Otway	Otway Coast	1952	Waterway, land and houses
356.3/12	Landslide	Guys Rd, The Heytesbury (Pau's)	Incomplete	Corangamite	Curdies	NA	Dairy land
356.3/13	Gully Erosion	Robbies Rd, Shelford (Meekes)	Completed	Golden Plains	Leigh	NA	Ag land
356.3/14	Streambank erosion	Jetty Rd, Clifton Springs	not started	City of Greater Geelong	Bellarine	Feb-2005	Road
356.3/15	Landslide	Great Ocean Rd Easternview (Clarkes)	not started	Surfcoast	Thompsons	1891	land houses to come
356.3/16	Streambank erosion	Golf Course, Clifton Springs	not started	City of Greater Geelong	Bellarine	2003	Waterway
356.3/17	Landslide	The Dungeon, Aire River	not started	Colac Otway	Gellibrand	1935	Waterway
356.3/18	Landslide	Great Ocean Rd (Cumberland River)	not started	Colac Otway	Otway Coast	2005	Road and users
356.3/19	Landslide	Great Ocean Rd (Browns Creek)	not started	Colac Otway	Otway Coast	1952	Road, buildings (dairy)
356.3/20	Landslide	Lake Elizabeth, Forrest	Completed	Colac Otway	Upper Barwon	1952	Waterways
356.3/21	Landslide	Morley Ave, Wye River	not started	Colac Otway	Otway	1964	Houses and roads
356.3/22	Landslide	Melba Parade, Anglesea	Incomplete	Surfcoast	Thompsons	1974	Houses and road
356.3/23	Landslide	Dorman St, Lorne	not started	Surfcoast	Otway Coast	1976	Houses
356.3/24	Landslide	Sunnyside Rd, Wongarra	not started	Colac Otway	Otway Coast	1986	Road
356.3/25	Landslide	Lal Lal Reserve	Completed	Moorabool	Moorabool	1990	People
356.3/26	Landslide	Bird Rock and coast, Jan Juc	not started	Surfcoast	Thompsons	2001	People
356.3/27	Landslide	Moorabool River, Sheoaks	not started	Golden Plains	Moorabool	2001	Water infrastructure and waterway
356.3/28	Landslide	The Dell, Clifton Springs	Completed	City of Greater Geelong	Bellarine	2001	People and reserve infrastructure
356.3/29	Landslide	Ocean Grove Lookout	not started	City of Greater Geelong	Bellarine	NA	Water and sewerage infrastructure
356.3/30	Landslide	Seymour Crescent, Apollo Bay	not started	Colac Otway	Otway Coast	Oct-2004	Infrastructure Water pipe line
356.3/31	Landslide	Turton's Track, Beech Forrest	not started	Colac Otway	Gellibrand	2005	Road and Tourist users
356.3/32	Landslide	Great Ocean Rd (General)	Completed	Colac	Otway Coast	1949	Road
356.3/33	Erosion	Horsehill West Rd, Elaine (Gallows)	Incomplete	Otway/Surfcoast	Otway Coast	2002	Waterway
356.3/34	Erosion	Tall Tree Road, Meredith	Incomplete	Moorabool	Leigh	2002	Waterway
356.3/35	Erosion	Magpie, Ballarat	not started	Golden Plains	Leigh	NA	Waterway Ag land and cultural
356.3/36	Erosion	Fisken Rd, Mt Helen	not started	Ballarat	Leigh	NA	Waterway
356.3/37	Erosion	Pennyroyal (Smiths)	Completed	Ballarat	Leigh	NA	Road
356.3/38	Landslide	The Bluff, Barwon Heads	not started	Colac Otway	Upper Barwon	NA	Ag land and waterways
356.3/39	Landslide	The Bluff, Barwon Heads	not started	City of Greater Geelong	Bellarine	Multiple	People
356.3/39	Erosion	Coronae Drive, Clifton Springs	not started	Geelong	Bellarine	2004	Waterways and houses
356.3/40	Erosion	Misery Moonlight (Lex Hadlers)	Completed	City of Greater Geelong	Bellarine	2004	Waterways and houses
356.3/41	Erosion	Spring Creek, Torquay	not started	Golden Plains	Woody Yallock	NA	Waterways and grazing land
356.3/42	Erosion	Canadian Gully, Ballarat	not started	Surfcoast	Thompsons	NA	Waterways
356.3/43	Erosion	Black Hill, Ballarat	not started	Ballarat	Leigh	NA	Waterway
356.3/44	Landslide	Glenmore Rd, Parwan Valley	not started	Ballarat	Leigh	NA	People and road
356.3/45	Landslide	Glenmore Rd, Parwan Valley	not started	Moorabool	Outside CCMA	NA	Road and waterway
356.3/45	Erosion	Pennyroyal (Clissolds)	Completed	Colac Otway	Upper Barwon	NA	Ag land
356.3/46	Erosion	Barrabool Hills	Completed	City of Greater Geelong	Mid Barwon	NA	Ag land
356.3/47	Erosion	Bulldog Reserve Illabarook	Completed	Golden Plains	Woody Yallock	NA	Ag land, waterways, reserve

Table 1 List of Initial Sites Chosen for Case Studies and Current Status.

5. Template for Documentation of Information

A standard template for the documentation of information was developed to assist with establishing a consistent approach to information gathering. The template was based on the overall premises of risk assessment and in particular aimed to answer the 5 key questions as listed in section 2.

Information has been assembled under the following key headings:

- Site Description
- Hazard Description
- Impacts (The event has already occurred) or
- Impacts (the event has yet to occur)
- Remedial Actions (no remediation has been undertaken yet) or
- Remedial Actions (remediation has already been undertaken)
- Ongoing Review and monitoring requirements
- Photos
- Site Sketches and Figures.

A blank template in word format is included in Appendix A.

6. Completed Case Studies and Discussion

As discussed case studies have been assembled under the current 2006/2007 CSHS program. Of the 44 sites were initially identified, 16 sites have now been completed comprising 6 erosion sites and 10 landslide sites.

The completed case study templates have been assembled in an accompanying A4 binder as an addendum to this report.

The nature of the hazards and the impacts on effected assets vary significantly from site to site. As such each case study should be consulted for specific information.

In general, the compilation of information relating to case studies proved to be challenging and required more resources and time than originally budgeted for. Site inspections were useful in gaining additional field information but site interviews were shown to be much more significant in gaining a fuller understanding of the circumstances leading to the event and the actions taken as a result. The assistance and field consultation skills of the local DPI extension officers, particularly Shari Wallis, are duly acknowledged and greatly appreciated in the preparation of these case studies.

A perceived benefit of individual case studies is that they provide specific detailed information on the consequences and impacts of erosion and landslides. Any future attempts at a cost benefit analysis of mitigation and remedial techniques and approaches aimed at reducing risk from such soil threatening process will be greatly enhanced with this added information.

The continued compilation of detailed case studies for a wide range of sites and hazards throughout the entire CCMA region is strongly recommended. As such, ongoing documentation of case studies should form part of any future CSHS programs.

Appendix A

Blank Case Study Template

1. Site Description

1.1 Site I.D.

1.2 Site address

1.3 Brief site description and general overview

1.4 Map datum/ Map projection/ Zone

1.5 Easting

1.6 Northing

1.7 Municipality

1.8 CCMA landscape zone

1.9 Previous ID

1.10 Previous Data Source

2. Hazard Description

2.1 Soil degradation type

2.2 Soil degradation sub-class

2.3 Description of hazard present on site or threatening site from above or below

2.4 Dimensions of Hazard (width, length and depth if appropriate)

2.5 Extent of Hazard (spatial area and volume if appropriate)

2.6 Magnitude of hazard (travel distance or rate of occurrence)

2.7 List previous reports or studies relevant to this site

2.8 Custodian of previous reports and studies

3. The Event Has Already Occurred

3.1 Date of first occurrence

3.2 Date of most recent re-activation or acceleration

3.3 Actual or postulated trigger event including magnitude and duration

3.4 Frequency of Trigger Event if known

3.5 What damage or impact occurred?

3.6 Was there a risk of injury or loss of life?

3.7 How important was it?

3.8 What asset classes were impacted?

3.9 What asset sub classes were impacted?

3.10 What are the asset values?

3.11 How severely were assets impacted?

3.12 Estimated cost of impact (including qualitative and quantitative costs for loss of asset, investigations, remedial works, cultural, business and environment)

4. Event Is Yet To Occur

- 4.1 Estimated likelihood of occurrence**
- 4.2 Expected period during which hazard is expected to occur**
- 4.3 What are the assets at risk**
- 4.4 What are the values of these assets?**
- 4.5 What is the consequence of failure or occurrence?**
- 4.6 How important is it?**
- 4.7 What are the remediation options?**
- 4.8 Will detailed design be needed or required?**
- 4.9 Who is likely to carry out design?**
- 4.10 Will remediation require specialist equipment?**
- 4.11 What is the likely cost of remediation**
- 4.12 How will effectiveness be monitored?**
- 4.13 How will remediation be funded?**

5. Remediation Has Already Been Undertaken

- 5.1 What remediation option was used?**
- 5.2 How was the site initially assessed?**
- 5.3 How was the remediation designed and by Who?**
- 5.4 Did it require specialist equipment or subcontractors?**
- 5.5 How effective has the remediation been?**
- 5.6 How was the effectiveness judged?**
- 5.7 Would other treatments worked here?**
- 5.8 Was it early intervention or reactive?**
- 5.9 What was the cost of remediation (including design, construction and implementation)?**
- 5.10 How was the remediation funded?**

6. No Remediation Has Been Undertaken Yet

- 6.1 What are the remediation options?**
- 6.2 How will the site be assessed?**
- 6.3 How will the remediation be designed and by who?**
- 6.4 Will it require specialist equipment or contractors?**
- 6.5 How will effectiveness be judged?**
- 6.6 Will it be early intervention or reactive?**
- 6.7 What is the likely overall cost of remediation?**
- 6.8 How will the remediation funded?**

7. Ongoing Review and Monitoring Requirements

- 7.1 What is the likely ongoing monitoring and review strategy?**
- 7.2 What is the nature of future monitoring and maintenance?**
- 7.3 What are the likely costs of monitoring and maintenance?**

Photos

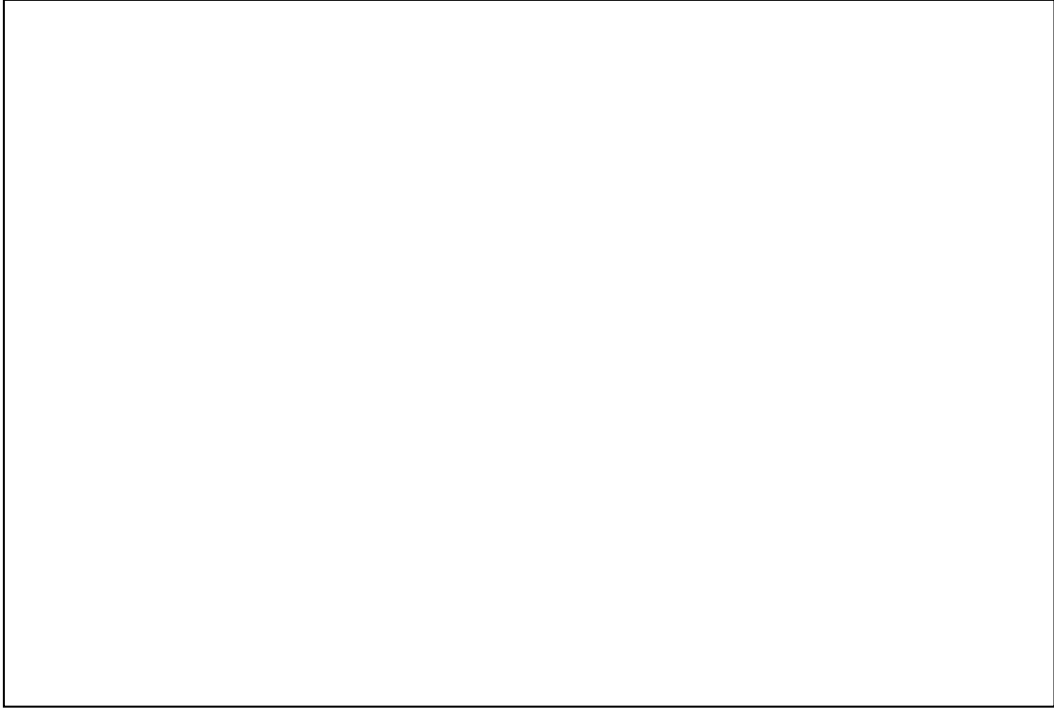


Photo 1

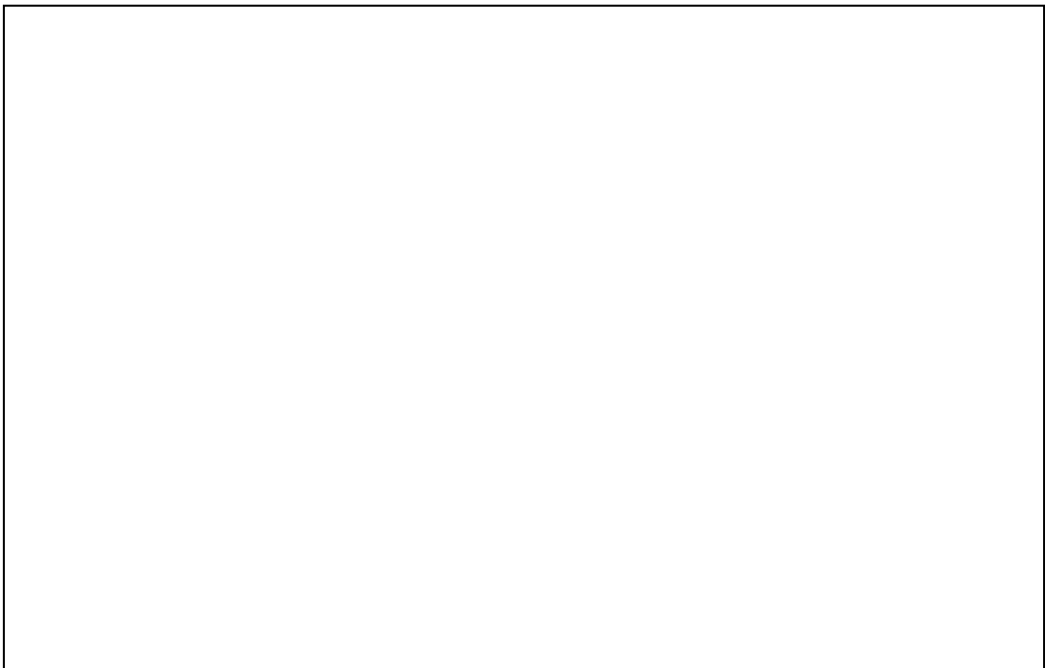


Photo 2

Sketches and Drawings

