
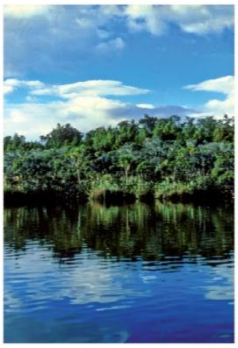

National Guidelines for Monitoring and Reporting Effects of Land Fragmentation

Envirolink Tool Grant: C09X1202/28950





Landcare Research
Manaaki Whenua

National Guidelines for Monitoring and Reporting Effects of Land Fragmentation

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Summary

The Resource Management Act of 1991 requires regional councils to safeguard the long-term, sustainable use of natural resources via integrated planning and resource management. Regional councils have particular concern about the long-term supply of land for primary production in the face of likely continued competition of land, especially urban and residential development. Increasing competition for land resources has the potential to increase land fragmentation going forward and substantially alter the possible range of land uses and associated ecosystem goods and services.

While policies and planning to manage land fragmentation effectively are increasing, monitoring of land fragmentation and its effects remain limited. A better understanding of local, region, and national land fragmentation trends would help regional councils evaluate current and possible future land use options, develop appropriate policy, plans and rules, and contribute to meeting evolving societal needs and desired outcomes.

These guidelines address the need for improved monitoring and reporting by providing a consistent and common set of methods and indicators to help regional councils assess trends in and effects of land fragmentation. The proposed guidelines will aid monitoring and reporting within individual regions, facilitate comparisons among regions, and help underpin consistent and robust national analysis and reporting.

The guidelines have been developed in collaboration by Landcare Research and the Regional Council Land Monitoring Forum under an Envirolink Tools Project grant C09X1202/28950 from the Ministry of Business, Innovation and Employment that ran from January 2013 to December 2014.

Land fragmentation for the purposes of these guidelines is any division to one or more dimensions of a land resource. Key factors to consider include:

- Biophysical features: how natural or man-made features such as topography, hydrological networks or infrastructure influence patterns of land use across landscapes and regions
- Property Rights: where particular activities can or cannot occur, including assignment of rights via land titles or restrictions and limitations from policies, plans, rules, etc.
- Ownership: who decides what activities occur with fewer owners; generally implying easier decision-making than more or many owners, although collective ownership may enable otherwise unviable land uses via pooled capital/resources.

While designing and developing the guidelines for monitoring land fragmentation, four key principles were followed:

1. Develop methods and indicators usable by all regional councils to support consistent, national monitoring and reporting

2. Keep indicators and reporting simple and increase complexity only as needs warrant

3. Avoid subjectivity, including terms such as “high class” or “highly versatile” soils or land

4. Use only nationally consistent, publically available, and authoritative underpinning data.

The main purpose of the guidelines is to help regional councils assess land supply for different types of primary production both currently and possibly in the future considering both direct and indirect effects of land fragmentation. Direct effects include any changes to the potential land uses at a particular location that result from changes to biophysical features, property rights or ownership at that location. Indirect effects include any changes to the potential land use at a particular location that result from changes to adjacent or neighbouring locations. Direct and indirect effects can occur independently or in tandem.

The guidelines provide methods and indicators to monitor land fragmentation and report its effects on land supply for primary production at four more progressively restrictive levels: Maximum Land Supply > Known Land Supply > Likely Land Supply > Restricted Land Supply (Table 1). The first three levels estimate direct effects of land fragmentation, e.g. changes that reduce the total land supply by splitting, dividing or reducing available land below thresholds useful for different types of primary production. Restricted Land Supply estimates indirect effects of land fragmentation by considering potential reverse sensitivity effects of one land use on another.

For each level the guidelines provide reporting indicators for the region, class(es) of interest, and individual polygons. The indicators specified primarily include size and shape metrics that best help estimate land supply for primary production. More complex indicators could also be generated from the underpinning database but their use and interpretation is generally more complex and therefore more limited.

The guidelines provide standard methods that can be adapted to suit the requirements of each regional council system. The methods include procedures for a) compiling a centralised regional land fragmentation database using publically available data, and b) generating indicators for reporting. A specific implementation of the methods in ArcGIS and associated Python code is provided in a technical appendix as an example and possible adaptation to specific regional council systems.

The use of public data has benefits and limitations. Benefits include reliance on uniform, authoritative and independent (i.e. non-council) data; avoidance of data access issues; and varying frequencies of data updates to support monitoring of both longer-term and shorter-term trends. Limitations include any inherent limitations in the primary data used as well as the need to use inference in some cases. Despite these limitations, reliance on public data avoids common issues associated with proprietary data including lack of access to data, inconsistent data, or restricted use of data.

The current guidelines focus on providing an initial set of standard methods and basic indictors to facilitate consistent pan-regional monitoring and reporting as requested by regional councils. However, we expect that the underpinning database, methods and indicators will be further enhanced and tailored to meet specific needs as regional councils gain experience in their use and application.

<table>
<tr><th colspan="4">LEVEL I: MAXIMUM LAND SUPPLY</th></tr>
<tr><th colspan="3">Method</th><th>Interpretation</th></tr>
<tr><td colspan="3">Region Area – Selected Biophysical Networks</td><td rowspan="3">Estimate land supply using a regional mosaic created by dividing the region into polygons using a combination of selected biophysical networks (e.g. transport, rivers & streams, etc.)
Regional mosaic polygons represent the largest contiguous land areas potentially available for primary production without considering any additional constraints, e.g. current land use/cover, property rights/subdivision, ownership
Regional mosaic polygons can be tracked over time by assigning unique IDs to assess broad trends in regional land fragmentation</td></tr>
<tr><th colspan="3">Indicators</th></tr>
<tr><td>Region:
Land Supply (hectares)
Number of Polygons (scalar)
Polygon Size Distribution (graph)</td><td>Class:
Class Land Supply (hectares)
Number of Class Polygons (scalar)
Class Polygon Size Distribution (graph)</td><td>Polygon (optional):
Polygon Area (hectares)
Polygon Shape</td></tr>
<tr><th colspan="4">LEVEL II: KNOWN LAND SUPPLY</th></tr>
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<tr><td colspan="3">Maximum Land Supply – Urban Areas – Protected Areas</td><td rowspan="3">Estimate land supply excluding known urban/built-up and protected areas from the Maximum Land Supply
Known Land Supply includes areas not currently under primary production but potentially available for conversion, e.g. unprotected indigenous forest, weeds, etc.</td></tr>
<tr><th colspan="3">Indicators</th></tr>
<tr><td>Region:
Known Land Supply (hectares)
Known Number of Polygons (scalar)
Known Polygon Size Distribution (graph)</td><td>Class:
Known Class Land Supply (hectares)
Known Number of Class Polygons (scalar)
Class Polygon Size Distribution (graph)</td><td>Polygon (optional):
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Polygon Shape (scalar)</td></tr>
<tr><th colspan="4">LEVEL III: LIKELY LAND SUPPLY</th></tr>
<tr><th colspan="3">Method</th><th>Interpretation</th></tr>
<tr><td colspan="3">Known Land Supply – Parcels ≤ Size Threshold with Electoral Address</td><td rowspan="3">Estimate land supply excluding likely areas of diffuse rural residential development (e.g. lifestyle blocks) from Known Land Supply using indirect evidence
Parcel size threshold can vary to reflect operational requirements of different types of primary production
Parcels of appropriate sizes without Electoral Address Points can also be used to assess future potential for land fragmentation, e.g. subdivided land still under primary production</td></tr>
<tr><th colspan="3">Indicators</th></tr>
<tr><td>Region:
Likely Land Supply (hectares)
Number of Polygons (scalar)
Polygon Size Distribution (graph)</td><td>Class:
Class Land Supply (hectares)
Number of Class Polygons (scalar)
Class Polygon Size Distribution (graph)</td><td>Polygon (optional):
Polygon Area (hectares)
Polygon Shape (scalar)</td></tr>
<tr><th colspan="4">LEVEL IV: RESTRICTED LAND SUPPLY</th></tr>
<tr><th colspan="3">Method</th><th>Interpretation</th></tr>
<tr><td colspan="3">Known Land Supply – Buffer Areas of Specified Land Uses</td><td rowspan="3">Estimate land supply to include potential indirect effects of land fragmentation (e.g. reverse sensitivity) by excluding areas of Likely Land Supply within a buffer distance of specified neighbouring land uses.
Specification of neighbouring land uses and buffer distances can vary as required to reflect relevant policies, plans and rules although some standards will be needed to support pan-regional and national analyses.</td></tr>
<tr><th colspan="3">Indicators</th></tr>
<tr><td>Region:
Restricted Land Supply (hectares)
Number of Polygons (scalar)
Polygon Size Distribution (graph)</td><td>Class:
Restricted Land Supply (hectares)
Number of Class Polygons (scalar)
Class Polygon Size Distribution (graph)</td><td>Polygon (optional):
Polygon Area (hectares)
Polygon Shape (scalar)</td></tr>
</table>

1 Introduction

Landcare Research and the Regional Council Land Monitoring Forum collaborated on a 2-year (January 2013 – December 2014) Envirolink Tools Project (CXXXXX) funded by the New Zealand Ministry of Business, Innovation and Employment to develop the guidelines contained in this document.

The guidelines are organised into four sections:

- Background
- Development and Overview
- Methods and Indicators
- Reporting

The background section summarises the need for consistent, national guidelines for monitoring and reporting trends in and effects of land fragmentation based on a review and associated survey of regional council policies, plans, and current monitoring efforts. The development and overview section summarises the key considerations and principles followed during guideline development and provides a broad overview of the guideline structures and methods. The indicators and methods section outlines the recommended methods for monitoring and reporting trends in and effects of land fragmentation including development of an underpinning database and specification of indicators for reporting. The reporting section provides a sample regional land fragmentation report for use as a template for regional councils to adapt to their own reporting requirements.

2 Background

As global, national and local population growth continues competition for land and soil resources will also increase (Curran-Cournane et al. 2014; Godfray et al. 2010a, b; Mackay et al. 2011; RSNZ 2011; Smith et al. 2010). Some land uses impact on the future potential, versatility, or capacity of the land for certain uses. For example, urban development may preclude or limit future use for agricultural production either directly through reduction of area available or indirectly through the introduction of adjacent incompatible uses (i.e. reverse sensitivity) (Andrews & Dymond 2012). The restriction of future land-use options represents an opportunity cost that should be considered in policy, planning, and resource management decisions that affect the allocation of land use (e.g. zoning) (Salant 1995).

All classes of productive land in New Zealand are under pressure from competing uses. In particular, opportunities for productive use of that land decline as urban areas expand and rural land is subdivided into smaller parcels. Such trends are particularly evident for highly capable land. Just over 5% of the New Zealand's land area (about 1.39 million ha) is classified as having high capability land (Rutledge et al. 2010), defined as land with Land Use Capability classes I or II (Lynn et al. 2009; Stephens et al. 1996). LUC classes I, II and III have experienced the highest rates of conversion to urban uses as a percentage of original area (5.6%, 3.9% and 2.3% respectively) over the period 1985–2002 (Rutledge et al. 2010). Conversion of LUC class I and II land to urban uses raises concerns because of the comparatively high productive capability of this land as well as its limited extent.

The Resource Management Act 1991 (RMA) provides a clear mandate for the management, protection and enhancement of soil resources at all levels of local government, as set out in the purpose of the RMA (section 5), local government is responsible for:

> *managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while –*
>
> a) *sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> b) *safeguarding the life-supporting capacity of air, water, soil and ecosystems, and*
>
> c) *avoiding, remedying, or mitigating any adverse effects of activities on the environment* (New Zealand Government 1991, p. 65).

Section 7 of the RMA further requires that local government give particular regard to any finite characteristics of natural and physical resources (e.g. finite stocks of land). Section 35 of the RMA requires that local authorities monitor and assess impacts on the land resource to help ensure that resource management interventions (policy) are appropriate and effective in maintaining land and soil resources.

Implementation of the RMA is via a three-tiered administrative structure – central, regional and territorial government authorities. Policy and plan documents at each tier of government sit within a 'hierarchy', with each subsequent policy or plan document having to "give effect" to higher order documents. Regional and territorial authorities have been established to be complementary, cooperative bodies within the hierarchical structure of statutory documents under the RMA.

Central government agencies have a policy and advisory role, for example to develop national policy statements (NPS) and national environmental standards (NES) to provide national direction to local level decision making. Responsibility for regional policy and regional consenting matters is the responsibility of regional and unitary authorities,[1] while local policy and consenting is the responsibility of territorial authorities (city and district councils) as set out in the RMA.

Below NPS and NES documents at the central government level sits Regional Policy Statements (RPS) and regional plans prepared by Regional or Unitary Councils. The RPS and Regional Coastal Plan are mandatory, while other regional plans (dealing with air, land and water resources) are discretionary. A regional plan must give effect to the RPS. City and district Councils are required to develop City and District Plans addressing land use and subdivision. City and District Plans must give effect to the RPS and must not be inconsistent with regional plans.

Local authorities have a responsibility to manage soil resources through developing and implementing informed policy. The policies and plans developed by councils in New Zealand include consideration of the allowable uses and activities for land among many competing demands, including agriculture, forestry, housing, recreation, tourism, and energy production, as well as being responsible for conserving biodiversity, managing biosecurity risks, maintaining clean water and air, iconic landscapes, and access to land for cultural and spiritual purposes.

2.1 Review of land fragmentation issues and responses in New Zealand

Although land fragmentation is occurring around New Zealand, it is not occurring uniformly within or across regions. Six regions identified land fragmentation as a regionally important issue; in remaining regions it was only of medium or low importance (Table 1). While varying in importance at a regional level, most regions reported some localities or hotspots where land fragmentation has become an important issue (e.g. the Wairau Plains in Marlborough). In those cases, hotspots include areas where subdivision for rural-residential development (e.g. lifestyle block) is occurring close to urban centres on land with relatively high productive capability.

While land fragmentation is commonly an issue regionally or locally, our review of land fragmentation knowledge and issues across regional and unitary councils highlighted that understanding of it and associated issues varies across councils. The lack of shared understanding stems partly from a lack of consistent terminology or definitions to help characterise, measure, monitor, and report land fragmentation trends, and many councils indicated a desire to develop more consistent terminology and definitions for land fragmentation. New Zealand is not alone in that regard. Based on a literature review, numerous definitions or conceptions of land fragmentation are used internationally, such as: the number and size of land uses and/or land parcels in the rural landscape; the number of

[1] Unitary authorities carry out combined regional and district council responsibilities.

parcels that make up an individual farm; and the spatial distribution of multiple parcels that make up a single farm.

Rural residential development is not seen as a negative process in its own right, but scattered, un-managed, and un-planned rural residential development can be expensive for councils as well as having potential financial and social impacts on local communities. Policy makers have favoured introducing rural zones to limit and delineate rural subdivision and development, as well as introducing policy and methods to implement transferable development rights, title amalgamation, and development guidelines.

Few regional plans included rules targeting land fragmentation, except for plans prepared by unitary authorities (Table 1). Such a result is not surprising, given that unitary authorities combine the functions, powers and responsibilities of both regional councils and territorial authorities. The lack of rules from regional councils (not unitary authorities) suggests they may be challenged under current governance arrangements to implement rules to manage land fragmentation effectively. In those cases, a regional council must work effectively with city and district councils to ensure city and district plans contain rules and provisions that help meet regional objectives and policies.

Nationally, regional and district coordination regarding land fragmentation issues was mixed. Some relationships were considered strong and effective. The Future Proof strategy in the Waikato and the Heretaunga Plans strategy in Hawke's Bay were good examples cited of effective collaborative efforts between regional councils, territorial authorities, and iwi to develop and agree coordinated plans to manage sub-regional growth over long time horizons. Several other successful cases were cited where district plan provisions effectively manage rural residential subdivision on land with high productive capability.

Other relationships were considered dysfunctional or non-existent, thus creating fundamental barriers to achieving policy goals. Lack of district plan provisions regarding rural subdivision, and/or weak implementation of district plan provisions were noted several times as contributing to land fragmentation issues. Therefore a key component in achieving successful management of land fragmentation requires effective coordination among regional policy statements, regional plans, district/city plans and district/city council implementation of the district plan provisions.

Table 1 Summary of land fragmentation importance, policies, rules and monitoring by region. Regional Councils are listed geographically from north to south and west to east. RPS = Regional Policy Statement. The number of stars indicate high (★★★), medium (★★) or low (★) regional importance

Region	Regional Importance	Policies & Plan Rules				Monitoring & Reporting
		1st Generation		2nd Generation		
		Policies	Plan Rules	Policies	Plan Rules	
Northland	★★★	☑ Operative RPS 1999	☐	☑ Proposed RPS 2013	☐	☐
Auckland	★★★	☑ Operative RPS 1999	☐	☑ Proposed Unitary Plan 2013	☑ (Rural Zones)	☑
Waikato	★★★	☐ Operative RPS 2000	☐	☑ Proposed RPS 2013	☐	☑
Bay of Plenty	★★★	☑ Operative RPS 1999	☐	☑ Proposed RPS 2010	☐	☐
Gisborne	★★★	☑ Operative RPS 2002	☐	-	-	☐
Hawke's Bay	★ (Heretaunga Plains locally important)	☐ Operative RPS 1995	☐	☑ Operative RPS 2006 (RPS Change 4 2011)	☐	☐
Taranaki	★	☐ Operative RPS 1994	☐	☐ Operative RPS 2009	☐	☐
Manawatu-Whanganui (Horizons)	★	☑ Operative RPS 1998	☐	☑ Proposed One Plan 2010	☐	☑ (Ad hoc)
Wellington	★	☑ Operative RPS 1995	☐	☑ Operative RPS 2013	☐	☑ (Ad hoc)
Nelson	★	☐ Operative RPS 1995	☐	-	-	☐
Marlborough	★ (Wairau Plains locally important)	☑ Operative RPS 1995	☑ (Rural Zones)	-	-	☑
West Coast	★	☐ Operative RPS 2000	☐	-	-	☐
Tasman	★★★	☑ Operative RPS 2001	☑ (Rural Zones)	-	-	☐
Canterbury	★	☑ Operative RPS 1998	☐	☑ Operative RPS 2013	☐	☐
Otago	★★	☐ Operative RPS 1998	☐	-	-	☐
Southland	★	☐ Operative RPS 1997		☑ Proposed RPS 2012		☐

2.2 Need for guidelines and indicators

While land fragmentation is an increasingly important issue, few councils currently monitor land fragmentation (Table 1). Those councils that undertake monitoring do not use consistent methods or indicators for measuring and reporting.

The lack of consistency prevents comparison among regional trends and, at a higher level, aggregation of results to support reporting at the national level. Long-term and nationally consistent monitoring is required to assess the cumulative impacts of land fragmentation across national, regional, and local scales. Councils currently lack consistent monitoring methods and tools to track trends in land fragmentation and its associated effects to provide the evidence needed to gauge policy effectiveness.

The absence of standard guidelines, methods and indicators hampers councils' ability to monitor and report land fragmentation accurately and consistently. As a result, the communication of information regarding land fragmentation among councils (regional and local) by council staff and other land managers can be confused and inaccurate. Furthermore, the correlation of regional indicators for land fragmentation at the national level and the sharing of data between regions become difficult, given the current lack of a nationally consistent approach. To address current gaps in monitoring and reporting land fragmentation and its associated effects and risks, national guidelines are needed to:

- ensure consistent characterisation of land fragmentation and the drivers of land fragmentation (e.g. land valuation and demographics) at local, regional and national scales
- quantify the effects of land fragmentation on land and soil resources
- understand the implications for allocation of land resources and long-term productive opportunities of the land and thresholds for productive use options.

Availability of national guidelines for monitoring land fragmentation will yield several key benefits:

- Provide consistent, enduring monitoring of land fragmentation trends nationally, regionally, and locally
- Support nationally consistent State of Environment monitoring and reporting guidance for land fragmentation
- Inform policy decisions by helping identify where land fragmentation policies are effective and where they are not effective
- Improve the clarity and accuracy of communicating the impacts of land fragmentation on primary production and raising the issue across scales.

3 Development and Overview

This section provides a broad overview of the guidelines, provides a working definition of land fragmentation, and outlines the key considerations and principles followed during guideline design and development.

3.1 Overview

Landscapes are dynamic and change constantly due to natural and man-made processes operating at different spatial and temporal scales. Over time some landscape features may decrease in extent and the remaining areas may become more isolated from each other, i.e. may become more fragmented. Such features would exhibit trends such as a decrease in total area across the landscape, an increase in the number of features, a tendency for individual features to reduce in size, and an increase in distance among remaining features.

Competition for land among different uses is one important process driving landscape change. Research to date has documented that land use conversions are decreasing the total land supply for primary production across New Zealand (Rutledge 2008; Rutledge et al. 2010; Mackay et al. 2011; Andrews & Dymond 2012; Curran-Cournane et al. 2014). Regional councils are concerned that those trends will continue, especially in the face of increasing demand from competing uses such as urban and residential development, and will continue to reduce New Zealand's capacity for primary production.

Regional councils are further concerned because research and monitoring thus far have focused primarily on documenting the quantity of change, i.e. total area converted either nationally or by region. To date councils have limited understanding regarding the patterns of conversion and the potential additive impacts that might be generated for primary production. Remaining areas may become too small or too isolated (fragmented) from one another to viably support certain types of primary production. A better understanding of such trends locally, regionally and nationally would help regional councils evaluate current and possible future land use options, develop appropriate policy, plans and rules, and contribute to meeting evolving societal needs and desired outcomes.

The main purpose of the guidelines is therefore to help regional councils answer the following question:

> *What is the current land supply for different types of primary production and how has land supply changed in the past and how might it change into the future due to direct and indirect effects of land fragmentation?*

Broadly, the approach taken involves periodically applying increasing levels of publically available information to provide four progressively more restrictive estimates of land supply for different types of primary production due to direct and indirect effects of land fragmentation. Direct effects include any changes to land supply at a particular location that result from changes at that location. Indirect effects include any changes to land supply at a particular location that result from changes to adjacent or neighbouring locations. Direct and indirect effects can occur independently or in tandem.

These guidelines address the need for improved monitoring and reporting by providing a consistent and common set of methods and indicators to help regional councils assess trends in and effects of land fragmentation. The proposed guidelines will aid monitoring and reporting within individual regions, facilitate comparisons among regions, and help underpin consistent and robust national analysis and reporting.

3.2 Land Fragmentation: Working Definition

As noted earlier, a consistent definition of land fragmentation in New Zealand is lacking. The guidelines therefore adopt the following working definition to facilitate shared analysis and discussion:

> *Land fragmentation is any division of one or more aspects of a land resource.*

Overall, the definition suggests a process whereby larger, contiguous areas become progressively smaller and likely more isolated from each other as a result of both natural and man-made disturbance events. In that regard it is consistent with similar definitions found in the literature (Forman 1995; Rutledge 2003). The definition is also intended to be flexible and does not prescribe any particular process of division/fragmentation or any particular aspect of a land resource.

3.3 Design Principles

While designing and developing the guidelines for monitoring land fragmentation, regional councils outlined four key design principles to follow:

1) Develop methods and indicators usable by all regional councils to support consistent, national monitoring and reporting

2) Keep methods and indicators simple in the beginning and introduce complexity as needed

3) Avoid subjectivity as much as possible including the use of contextual terms such as “high class soils” or “highly versatile land”

4) Use only nationally consistent, publically available and authoritative underpinning data.

Keeping the design principles in mind, especially the availability of nationally consistent public data, the guidelines take a practical approach and consider the following three key aspects of land resources that collectively influence patterns of land use across landscape and regions:

- Biophysical features (e.g. land cover): natural or man-mad features such as topography, hydrological networks or infrastructure networks
- Property rights: where and/or when activities may or may not occur as delineated by land titles, policies, plans, rules, covenants, etc. individually or in combination
- Ownership: deciding where and when to undertake which activities.

The most is known about biophysical features (i.e. land cover) from data sources such the Land Cover Database and LINZ topographic information. With the public release of the cadastral database by LINZ, information on property rights has increased, including location (e.g. parcels and lots) and in some cases specific purpose (e.g. roads). Current ownership information principally distinguishes most public from private land via data layers such as the national conservation estate managed by the Department of Conservation, also the parcel database, and the Protected Areas Network (PAN-NZ) database informally maintained by Landcare Research.

4 Guidelines

This section provides the guidelines for monitoring and reporting trends in and effects of land fragmentation on primary production. The guidelines include a conceptual overview of the approach, methods for compiling the underpinning database and calculating recommended indicators, and a template to use for monitoring and reporting. The methods provided do not have any specific technical requirements (e.g. operating system, geographic information systems, etc.) and could be implemented within any regional council system by a competent spatial analyst. Appendix 1 contains an example of the methods implemented as a series of ArcGIS ModelBuilder models and associated Python scripts based on those models for inspection and possible use/adaptation. Electronic copies of both the models and Python scripts are also available for access by regional councils or other interested parties.

The application of these guidelines will help regional councils assess land fragmentation trends regionally, highlight differences among different types of primary production, and pinpoint local issues for further investigation via more detailed interrogation of information on individual polygons or perhaps on clusters of polygons.

4.1 Conceptual Overview

The guidelines provide methods and indicators to monitor land fragmentation and report its effects on land supply for primary production at four progressively more restrictive levels: Maximum Land Supply (Level I) > Known Land Supply (Level II) > Likely Land Supply (Level III) > Restricted Land Supply (Level IV) (Table 2). The first three levels primarily estimate the direct effects of land fragmentation, e.g. changes that reduce the total land supply by dividing land resources below thresholds useful for different types of primary production. Restricted Land Supply estimates the indirect effects of land fragmentation by considering potential reverse sensitivity effects of one land use on another.

For each level the guidelines monitor the same set of indicators to promote ease of calculation, facilitate comparability among levels, and help interpretation. The set of indicators include: land supply (area in hectares) for primary production for individual polygons, classes or the region; the number (scalar) and size distribution (graph) of polygons; and for individual polygons a shape index (scalar). More complex indicators could also be generated from the underpinning database but their interpretation is generally more complex, their utility is limited and they are therefore not currently recommended.

Table 2 Overall land fragmentation monitoring and reporting framework

LEVEL I: MAXIMUM LAND SUPPLY	
Method	Interpretation
Region Area – Selected Biophysical Networks	Estimate land supply using a regional mosaic created by dividing the region into polygons using a combination of selected biophysical networks (e.g. transport, rivers & streams, etc.) Regional mosaic polygons represent the largest contiguous land areas potentially available for primary production without considering any additional constraints, e.g. current land use/cover, property rights/subdivision, ownership Regional mosaic polygons can be tracked over time by assigning unique IDs to assess broad trends in regional land fragmentation
LEVEL II: KNOWN LAND SUPPLY	
Method	Interpretation
Known Land Supply – Parcels ≤ Size Threshold with Electoral Address	Estimate land supply excluding known urban/built-up and protected areas from the Maximum Land Supply Known Land Supply includes areas not currently under primary production but potentially available for conversion, e.g. unprotected indigenous forest, weeds, etc.
LEVEL III: LIKELY LAND SUPPLY	
Method	Interpretation
Known Land Supply – Parcels ≤ Size Threshold with Electoral Address	Estimate land supply excluding likely areas of diffuse rural residential development (e.g. lifestyle blocks) from Known Land Supply using indirect evidence Parcel size threshold can vary to reflect operational requirements of different types of primary production Parcels of appropriate sizes without Electoral Address Points can also be used to assess future potential for land fragmentation, e.g. subdivided land still under primary production
LEVEL IV: RESTRICTED LAND SUPPLY	
Method	Interpretation
Known Land Supply – Buffer Areas of Specified Land Uses	Estimate land supply to include potential indirect effects of land fragmentation (e.g. reverse sensitivity) by excluding areas of Likely Land Supply within a buffer distance of specified neighbouring land uses. Specification of neighbouring land uses and buffer distances can vary as required to reflect relevant policies, plans and rules, although some standards will be needed to support pan-regional and national analyses.

The primary indicator reported at each level is land supply for primary production, i.e. an estimated answer to the question posed above, "how much land is available for primary production". In that regard, the recommended monitoring and reporting focuses primarily on the outcome(s) of land fragmentation for primary production, which is the key issue of interest to regional councils, and secondarily on the process of land fragmentation.

Land supply is first estimated for individual polygons. To estimate land supply for different classes, such as for a specific type of primary production, the areas of polygons greater than or equal to a size threshold specific to that class are summed. To estimate the regional land supply, the areas of all polygons are summed together. By definition, land supply for any individual class will be less than or equal to the regional land supply. If expected trends in land competition and land-use change continue, estimates of land supply for primary production will decline over time, e.g. some polygons will become smaller and some/many/all class and regional totals will decrease.

The indicators for number of polygons (scalar), polygon size distribution (graph), and an optional polygon shape index (perimeter to area ratio) help monitor the process of and trends in land fragmentation. The first two indicators are recommended as standard reporting. The shape index is optional and likely of more use in specific cases where more detailed analysis of individual polygons is needed to evaluate their viability for primary production. Similar to land supply, if expected trends continue, the number of polygons will increase and polygon-size distributions will shift towards smaller values for both regional and class polygons. Trends in shape index for individual polygons will likely show more variability. The broad trend would likely be an overall decrease as more polygons become smaller/are created that have lower perimeter to area ratios, although some polygons may show increases in the index value depending on the way in which division occurs.

The non-marine regional boundary serves as the starting point (Area of Interest or AOI) for the analysis including the total non-marine area in hectares for the region. Each level then identifies areas known or likely to be unavailable for primary production and subtracts those areas from the AOI to estimate land supply for primary production, either overall or for specific types of primary production as needed. Layering builds on itself as the land supply from a higher level serves as base for analysis at the next lower level. As a result, estimates of land supply for primary production become progressively smaller (i.e. fewer hectares) and more restrictive going from Level I to Level IV.

Maximum Land Supply (Level I) is estimated by overlaying water (rivers, lakes, ponds) and transport networks (roads, railways) over the AOI. Water and transport are key biophysical features that broadly organise landscapes. Excluding those features from the AOI creates a regional network of polygons, each of which delineates a contiguous area available for primary production (on land) without considering any additional constraints including current land uses (Fig. 1). In other words, the resulting polygons represent the largest "free to operate" contiguous areas potentially available to primary production, although clearly the actual area available will be smaller (Fig. 2a). Nonetheless, the resulting regional mosaic of polygons provides a useful coarse filter to evaluate and compare land fragmentation trends both spatially and temporally within and among regions. For example, additions to transport networks will likely increase the number of regional mosaic polygons over time. The rate of increase in the number of regional mosaic polygons could serve as a "speedometer" of land fragmentation. In addition, polygons can be given unique IDs to help monitoring such as targeting particular areas for further analysis or reporting or tracking specific polygons as barometers of change in different landscape contexts.

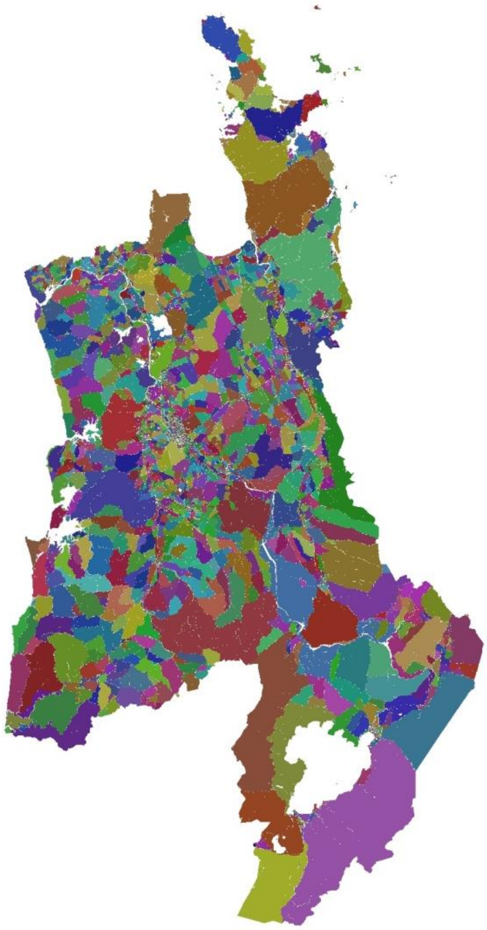

Figure 1 Regional mosaic for the Waikato Region used to estimate Maximum Land Supply. White areas depict water and transport excluded from the estimation of land supply. Coloured areas represent regional mosaic polygons.

Known Land Supply (Level II) is estimated by identifying known areas of non-primary production land uses and excluding them from the Maximum Land Supply (Fig. 2b). The principal areas identified include urban and protected areas. The former come from the Land Cover Database and LINZ topographic data and the former come from the Protected Areas Network (PAN-NZ) database unofficially maintained by Landcare Research. The exclusion of urban and protected areas has multiple effects, including removal of many of the smallest regional mosaic polygons, which typically but not exclusively occur in urban areas, reduction in area of larger polygons, and convolution of shape of other polygons.

Likely Land Supply (Level III) is estimated by identifying likely areas of diffuse urban/rural residential development (e.g. lifestyle blocks) from the Known Land Supply (Fig. 2c). Regional councils identified the continued growth and development of rural residential development as a key motivator for improved monitoring of land fragmentation and its effects, as research has demonstrated that such development has potentially significant impacts on land and soil resources (Rutledge 2008; Rutledge et al. 2010; Andrews & Dymond 2012; Cournan-Cournane et al. 2014). Consideration of such development was one of the more challenging aspects of land fragmentation to asses given reliance on public data.

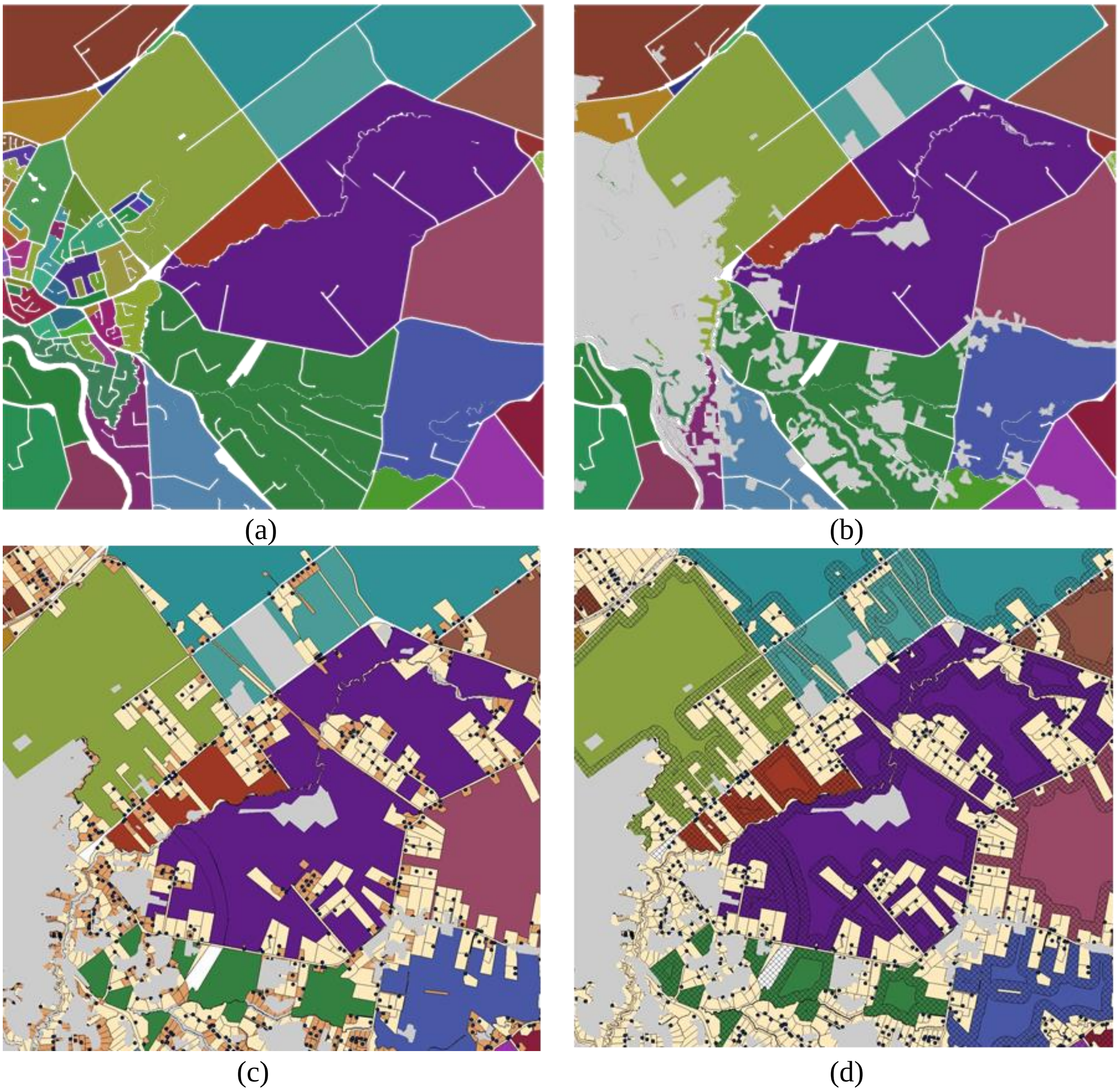

Figure 2 Example AOI southeast of Hamilton showing (a) Maximum Land Supply, (b) Known Land Supply, (c) Likely Land Supply and (d) Restricted Land Supply. White areas represent water and transport networks, grey areas represent urban and protected areas, orange and beige represent parcels ≤ 1 hectare and ≤ 4 hectares in size, respectively, and crosshatched areas represent buffer areas ≤ 100 meters from parcels ≤ 4 hectares in size.

An exploration of available public data sources identified a combination of parcels and electoral address points as a suitable proxy for primary land use data. Smaller parcels (e.g. 4 hectares or less in size) with electoral address points correspond well to locations of existing rural residential development (Figs 3–8). Electoral address points represent legally-defined addresses listed by a person when enrolling to vote and are updated as part of the cadastral database system maintained by LINZ. Together parcels and address points constitute a nationally consistent, frequently updated means to track likely trends in rural residential development. As evidenced in Figures 3–8, parcels with associated electoral address points supplement and enhance data on urban land uses derived from both the LCDB and LINZ topographic data. In some cases (Figs 3, 4, 6, 7) they extend known urban areas.

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Figure 3 Example of parcels ≤ 4 hectares in size with electoral address points near Omiston Road, Auckland. Grey areas represent urban areas (i.e. built-up areas) and light green areas represent agriculture (i.e. high producing exotic grassland) as identified by the Land Cover Database. Black represents parcel boundaries greater than 4 hectares in size. Blue represents parcel boundaries less than or equal to 4 hectares in size.

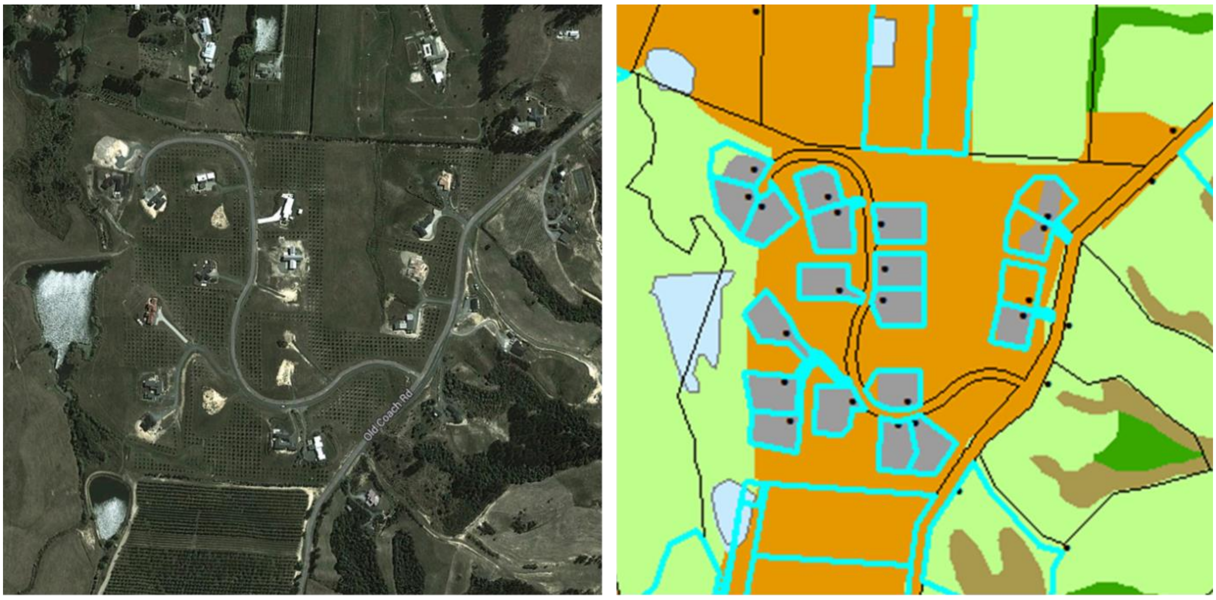

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Figure 4 Example of parcels ≤ 4 hectares in size with electoral address points near Old Coach Road, Tasman. Grey areas represent urban areas (i.e. built-up areas) and light green areas represent agriculture (i.e. high producing exotic grassland) as identified by the Land Cover Database. Black represents parcel boundaries greater than 4 hectares in size. Blue represents parcel boundaries less than or equal to 4 hectares in size.

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Figure 5 Example of parcels ≤ 4 hectares in size with electoral address points near Pukekohe East Road, Auckland. Light green areas represent agriculture (i.e. high producing exotic grassland) as identified by the Land Cover Database. Black represents parcel boundaries greater than 4 hectares in size. Blue represents parcel boundaries less than or equal to 4 hectares in size.

In other cases (Figs 5 and 8) they identify otherwise absent urban land uses, which likely reflects differences in the currency of the information used, e.g. parcel data being more recent than the underlying primary data sources (e.g. aerial photography) used in LCDB or LINZ topographic products.

In addition, parcels without associated electoral addresses highlight existing areas of (sub)division of property rights that have likely not yet been exercised, e.g. an owner has subdivided part of a property but not yet sold it to others. Regional councils could also estimate likely future land supply by excluding all parcels less than a certain size threshold and not just those with an electoral address point.

Lastly parcel threshold sizes can be varied to reflect the operating requirements of different types of primary production when estimating Likely Land Supply. Mean farm sizes vary from around 10 hectares or less for many horticultural activities (flowers, fruits, vegetables, and viticulture), to 10s to 100s of hectares (beef farming, arable farming, dairy farming), to 100s to 1000s of hectares (sheep farming) (Fig. 9). The parcel size threshold could be varied along a sliding size scale to identify potential discontinuities in effects, e.g. a substantial decrease in land supply overall or for certain types of primary industry when parcel sizes fall below a specified threshold.

Restricted Land Supply (Level IV) is estimated by identifying areas within specified distances of potentially sensitive land uses (i.e. buffers) and excluding those areas from Likely Land Supply (Fig. 2d). Restricted Land Supply could be generic, i.e. buffer and exclude all areas within a specified distance(s) of sensitive land(s) for the entire region (worst case) or targeted towards specific classes, i.e. buffer areas within a specified distance of a particular sensitive land use and exclude areas only for neighbouring uses that may be problematic. In the latter case estimates of Likely Land Supply could vary among the classes of interest. As a rule of thumb Restricted Land Supply (Level IV) will likely be more useful as a targeted rather than generic indictor.

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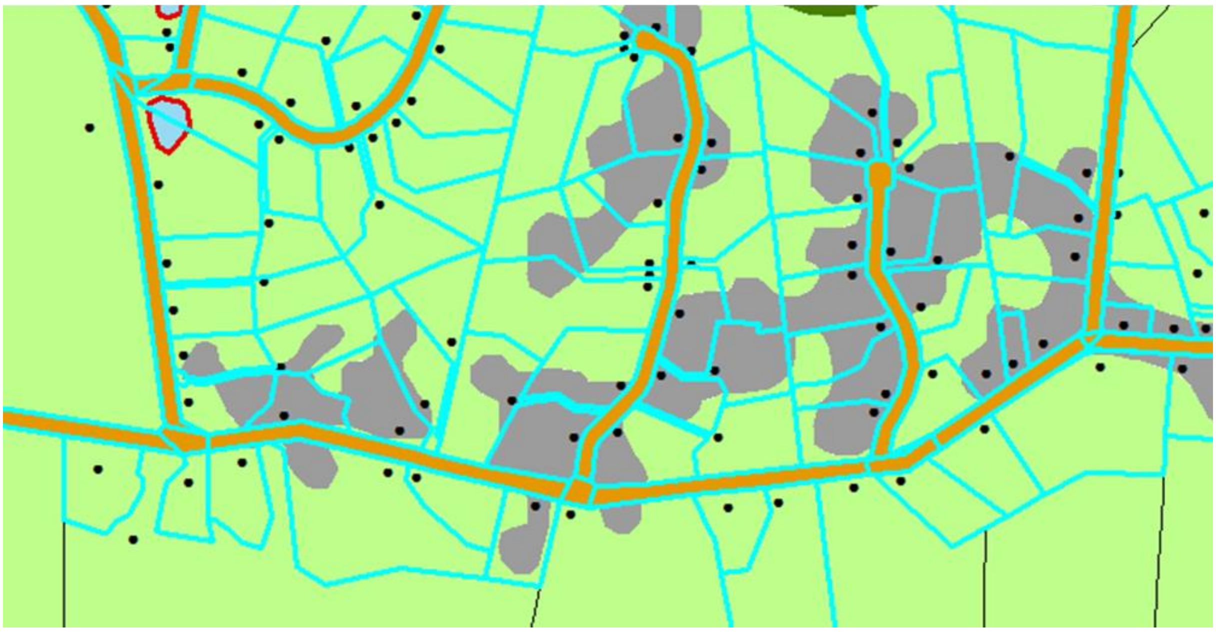

Figure 6 Example of parcels ≤ 4 hectares in size with electoral address points near Rotokauri Road, Hamilton, Waikato. Grey areas represent urban areas (i.e. built-up areas) and light green areas represent agriculture (i.e. high producing exotic grassland) as identified by the Land Cover Database. Black represents parcel boundaries greater than 4 hectares in size. Blue represents parcel boundaries less than or equal to 4 hectares in size.

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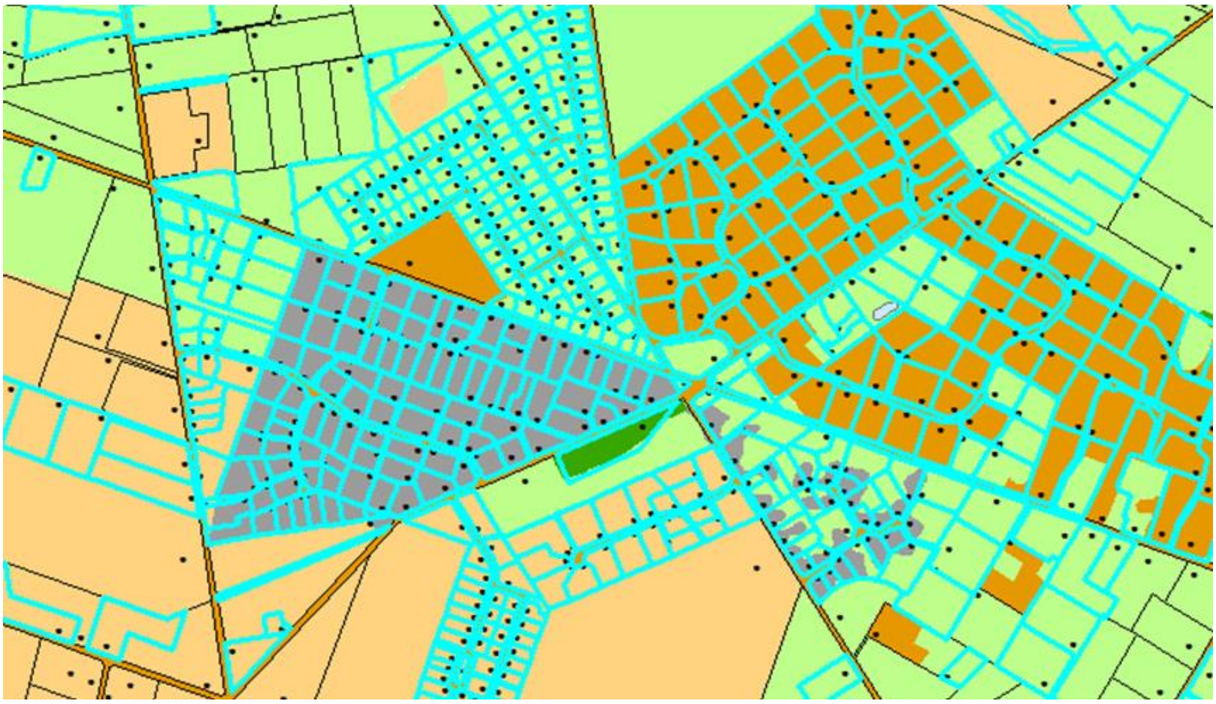

Figure 7 Example of parcels ≤ 4 hectares in size with electoral address points near Tram Road, Christchurch, Canterbury. Grey areas represent urban areas (i.e. built-up areas) and light green and orange areas represent agriculture (i.e. high producing exotic grassland) as identified by the Land Cover Database. Black represents parcel boundaries greater than 4 hectares in size. Blue represents parcel boundaries less than or equal to 4 hectares in size.

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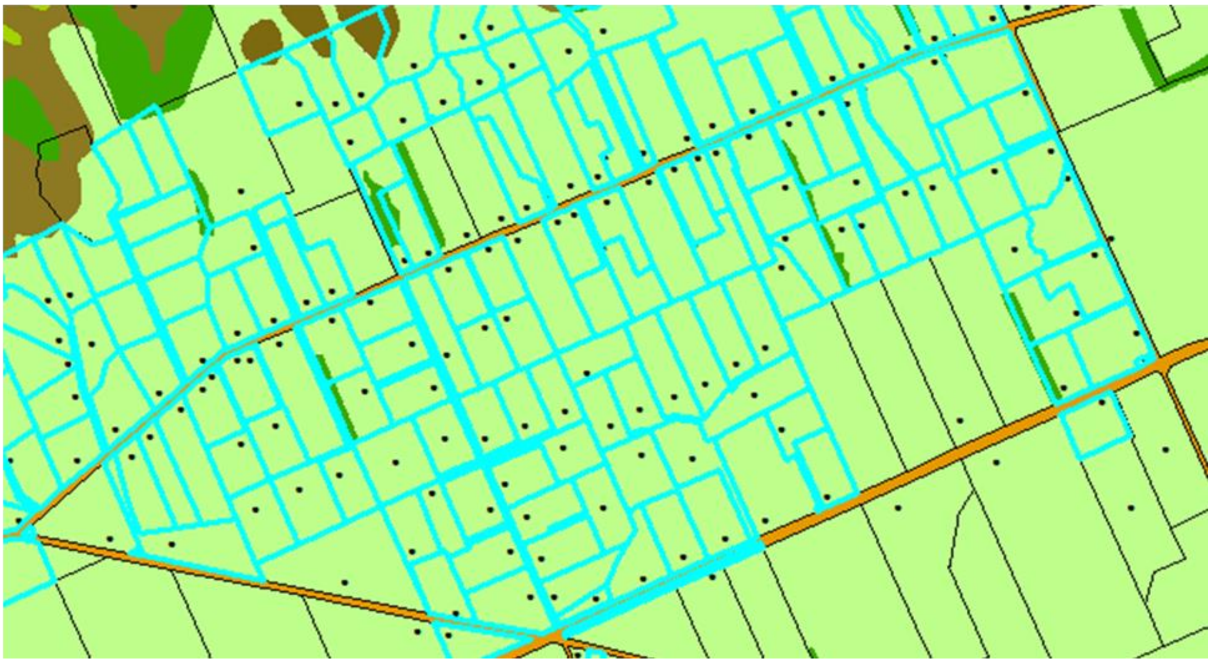

Figure 8 Example of parcels ≤ 4 hectares in size with electoral address points near Tirohanga Road, Mosgiel, Otago. Grey areas represent urban areas (i.e. built-up areas) and green areas represent agriculture (i.e. high producing exotic grassland) as identified by the Land Cover Database. Black represents parcel boundaries greater than 4 hectares in size. Blue represents parcel boundaries less than or equal to 4 hectares in size.

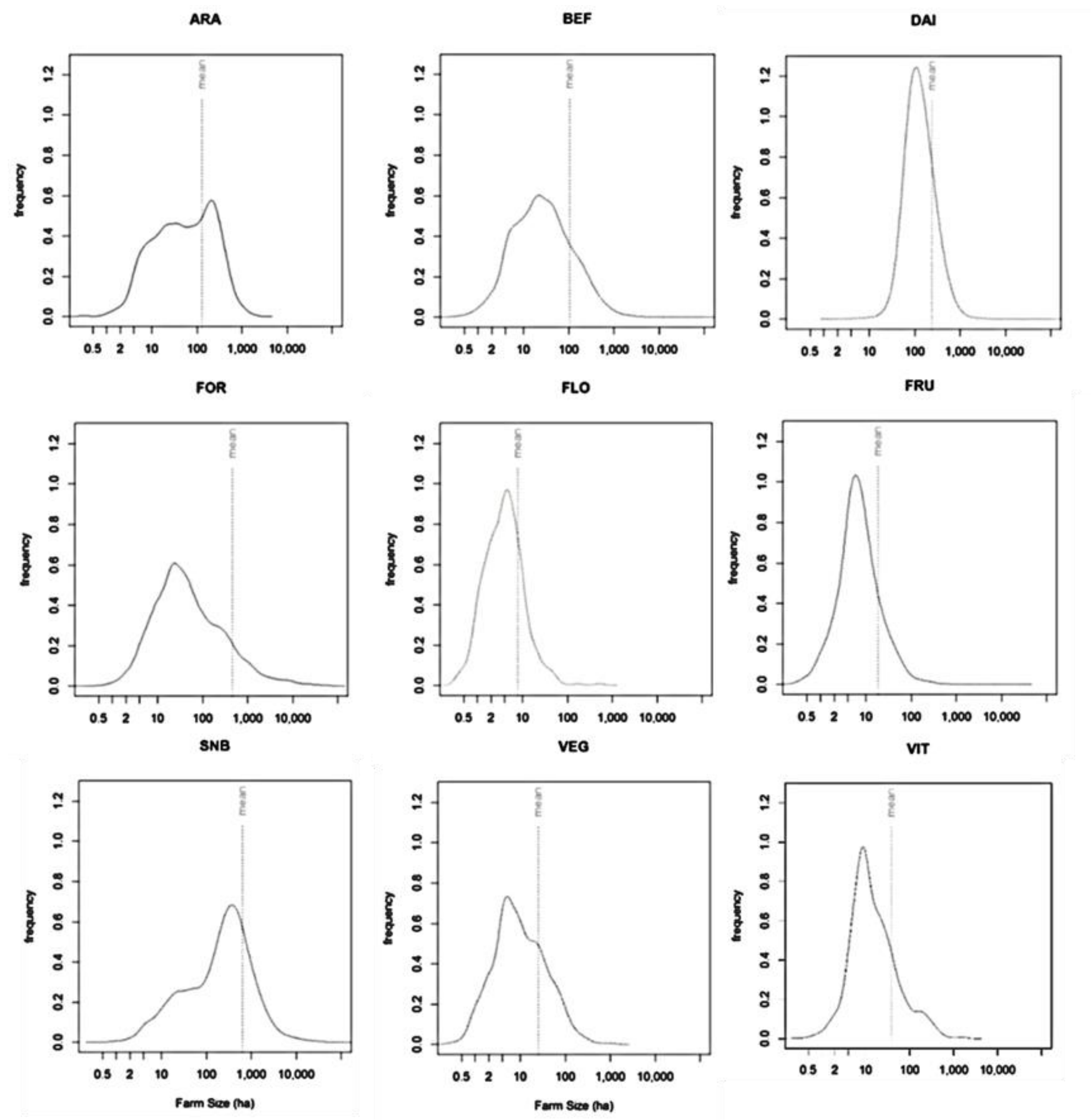

Figure 9 Distribution of farm sizes based on Agribase 2014 data. ARA = Arable, BEF = Beef, DAI = Dairy, FOR = Forestry, FLO = Flowers, FRU = Fruit, SNB = Sheep and Beef, VEG = Vegetables, VIT = Viticulture.

4.2 Database Development

Database development consists of two steps: 1) collecting and curating the required data layers, and 2) processing the data layers and analyzing the results to produce the indicators required for reporting. As each council has its own systems and requirements, specific methods implemented will vary among councils. The methods provided are therefore deliberately generic and avoid the use of any specific systems or technologies, e.g. operating systems, programming languages, geographic information systems.

4.2.1 Data Collection and Curation

All data sources are publically available (Table 2) via download from on-line data services including LINZ's Data Service (data.linz.govt.nz), Koordinates (www.koordinates.com), and Landcare Research's LRIS Portal (lris.scinfo.org.nz). For protected areas the recommended minimum data to use is the Public Conservation Areas spatial data layer available from the koordinates website. That data layer primarily identifies public conservation lands managed by the Department of Conservation under the provisions of several key pieces of legislation including the National Parks Act 1980, Conservation Act 1987, Reserves Act 1977, and the Wildlife Act 1953. Such areas include national parks, conservation parks, wilderness areas, ecological areas, amenity areas, wildlife management areas, wildlife sanctuaries, scenic reserves, etc. The Public Conservation data layer also includes some other protected areas managed by agencies other than the Department of Conservation. While not available publically, data on private covenants on private land and kawenata on Māori land are available on request from, respectively, the Queen Elizabeth II National Trust (www.openspace .org.nz) and Nga Whenua Rahui (http://www.doc.govt.nz/getting-involved/run-a-project/funding/nga-whenua-rahui/nga-whenua-rahui-fund/). Regional councils could also use any in-house data on protected areas as deemed appropriate.

Frequency of update varies among the data sources, which will affect the frequency of monitoring and reporting of land fragmentation trends and effects. For Levels I (Maximum Land Supply) and II (Known Land Supply), the Land Cover Database, which has the longest update period (4–5 years), is the limiting factor. Levels III (Likely Land Supply) and IV (Known Land Supply) can be updated more frequently as they rely on parcel data, which is updated at least monthly, to estimate changes in the extent of diffuse rural residential development and its effects directly and indirectly (i.e. reverse sensitivity). Monitoring could occur relatively frequently (e.g. monthly or quarterly) via analysis of updated parcel and electoral address data, although formal reporting may occur less frequently (e.g. annually).

4.2.2 Data Processing and Analysis

Data processing and analysis involve development of methods (procedures, algorithms, work flows, etc.) to combine the required data layers to delineate the four levels of land supply for primary production and calculate associated indicators. Because regional councils have different systems with unique capabilities and specifications, the methods outlined are generic. They are described using common spatial analysis terminology that each council can interpret and tailor to their own systems as required.

The methods outline a workflow (i.e. series of steps) to a produce four data layers, one for each of the four levels of analysis. The four new data layers provide the basis for producing the recommended set of indicators. The example methods in Appendix 1 outline an alternative strategy that combines all input data layers into a single combinatorial database from which all indicators can be calculated. The latter strategy is more computationally intensive but provides more flexibility and options for undertaking additional analyses. Regional councils can choose to implement either strategy or develop their own strategy provided it uses the recommended data and follows the recommended methods.

Recommended indicators could be calculated directly within the spatial analysis system or the attribute tables from the output data layers could be imported into an external software package (e.g. R, Microsoft Excel, etc.) for further analysis as desired.

Table 3 Spatial data layers required for monitoring and reporting land fragmentation

Spatial Data Layer	Source	Update Frequency	Level(s) Used			
			I	II	III	IV
Regional Council Boundary Annual Pattern High Resolution Clipped	Statistics New Zealand	Annual	✓	✓	✓	✓
Lake Polygons	LINZ	At least annually	✓	✓	✓	✓
Land Cover Database	Landcare Research	4–5 Years (if funding is available)	✓	✓	✓	✓
Pond Polygons	LINZ	At least annually	✓	✓	✓	✓
Primary Hydro Parcels	LINZ	~Monthly	✓	✓	✓	✓
Primary Land Parcels	LINZ	~Monthly	✓	✓	✓	✓
Primary Road Parcels	LINZ	~Monthly	✓	✓	✓	✓
River Polygons	LINZ	At least annually	✓	✓	✓	✓
Airport Polygons	LINZ	At least annually		✓	✓	✓
Building Polygons	LINZ	At least annually		✓	✓	✓
Cemetery Polygons	LINZ	At least annually		✓	✓	✓
Dump Polygons	LINZ	At least annually		✓	✓	✓
Golf Course Polygons	LINZ	At least annually		✓	✓	✓
Gravel Pit Polygons	LINZ|	At least annually		✓	✓	✓
Landfill Polygons	LINZ	At least annually		✓	✓	✓
Mine Polygons	LINZ	At least annually		✓	✓	✓
Protected Areas	Various*	At least annually		✓	✓	✓
Pumice Pit Polygons	LINZ	At least annually		✓	✓	✓
Residential Area	LINZ	At least annually		✓	✓	✓
Electoral Addresses	LINZ	~Monthly			✓	✓

*Koordinates for Public Conservation Layer (recommended minimum data required); QE II National Trust and Nga Whenua Rahui for private covenants and kawenata, respectively; councils for Local Purpose and other types of reserves

To help readability and interpretation the methods outlined use bold and capitalisation for procedures (e.g. **Union**) italics for variables such as data layers and field names (e.g. *Primary Land Parcels*) and single quotes and italics for field values (e.g. *'road'*). Steps list data layers, field names, field values, etc., alphabetically when two or more occur together.

Level I – Maximum Land Supply Methods

The methods outline steps to delineate water and transport networks from a range of data sources and remove them from the regional footprint. The new data layer created, *Max_Land_Supply*, is the regional mosaic of polygons described earlier (Table 1). To generate class indicators, the *Max_Land_Supply* data layer would need to be combined with other data layers, e.g. combine with the Land Resource Inventory data layer to estimate effects on land use capability classes.

1. **Select** from data layer *Land Cover Database* polygons where field *Name_2012* = '*Transport Infrastructure'* and then **Save Selection** as new data layer *LCDB_Transport*

2. **Select** from data layer *Land Cover Database* polygons where field *Name_2012* = '*River'* or *'Lake or Pond'* and then **Save Selection** as new data layer *LCDB_Water*

3. **Select** from data layer *Primary Land Parcels* polygons where field *parcel_intent* = '*Railway'* and then **Save Selection** as new data layer *Parcels_Railway*

4. **Select** from data layer *Primary Land Parcels* polygons where field *parcel_intent* = '*Riverbed'* or *'Streambed'* and then **Save Selection** as new data layer *Parcels_Water*

5. **Union** data layers *Regional Council Annual Pattern Clipped High Definition*, *Lake Polygons*, *LCDB_Transport*, *LCDB_Water*, *Parcels_Railway*, *Parcels_Water*, *Pond Polygons*, *Primary Hydro Parcels, Primary Road Parcels*, *River Polygons* to create new data layer *Max_Land_Supply_Union*

6. **Select** from data layer *Max_Land_Supply_Union* all polygons that are not *Lake Polygons*, *LCDB_Transport*, *LCDB_Water*, *Parcels_Railway*, *Parcels_Water*, *Pond Polygons*, *Primary Hydro Parcels, Primary Road Parcels*, or *River Polygons* and then **Save Selection** as new data layer *Max_Land_Supply*

Other workflows are possible depending on the capabilities of the spatial analysis system and analyst. For example, the ESRI ArcMap system includes an **Erase** function that could be used instead, i.e. **Erase** each of the data layers listed in the **Union** from the regional boundary.

Level II – Known Land Supply

The methods outline steps to identify current known areas of non-primary production land uses from a range of data sources and remove them from the maximum land supply to create known land supply. The primary focus is on urban and protected areas that are currently unavailable for primary production and likely to remain unavailable for primary production into the future. The new data layer created, *Known_Land_Supply*, forms the basis for calculating all Level II indicators.

1. **Select** from data layer *Land Cover Database* polygons where field *Name_2012 = 'Built-up Area (settlement)'* or *'Surface Mine or Dump'* or *''Urban Parkland/Open Space'* and then **Save Selection** as new data layer *LCDB_Urban*

2. **Select** from *Primary Land Parcels* polygons where *parcel_intent = 'DCDB'* or *'Fee Simple Title"* or *'Maori*' and then **Reverse Selection** and then **Save Selection** as *Parcels_Excluded*

Step 2 is intended to remove from consideration parcels that are unavailable to primary production given their intent such as legalisation parcels or parcels with "vestings on deposit" to create various reserves, etc. Nationally that set of parcels make up less than 1% of all primary land parcels by number and less than 2% by area. Excluding those parcels will slightly reduce estimates of Known Land Supply and, subsequently, Likely Land Supply and Restricted Land Supply.

3. **Union** data layers *Max_Land_Supply*, *Airport Polygons, Building Polygons, Cemetery Polygons, Dump Polygons, Golf Course Polygons, Gravel Pit Polygons, Landfill Polygons, LCDB_Urban, Mine Polygons, Parcels_Excluded, Protected Areas, Pumice Pit Polygons, Residential Areas* to create new data layer *Known_Land_Supply_Union*

4. **Select** from data layer *Known_Land_Supply_Union* all polygons that are not *Airport Polygons, Building Polygons, Cemetery Polygons, Dump Polygons, Golf Course Polygons, Gravel Pit Polygons, Landfill Polygons, LCDB_Urban, Mine Polygons, Protected Areas, Pumice Pit Polygons, Residential Areas* and then **Save Selection** as new data layer *Known_Land_Supply*

Level III – Likely Land Supply

The methods outline steps to identify likely areas of diffuse urban/rural residential development that may restrict some types of primary production. The new data layer created, *Likely_Land_Supply*, forms the basis for calculating all Level III indicators.

Calculations of *Likely Land Supply* depend on the parcel size threshold specified. Recommended size thresholds are outlined in the reporting section.

1. **Select** from *Primary Land Parcels* polygons where *parcel_intent = 'DCDB'* or *'Fee Simple Title"* or *'Maori*' and then **Save Selection** as *Primary_Land_Parcels_LevelIII_Included*

This step filters out parcels already excluded earlier in the *Known Land Sup*ply analysis.

2. **Union** data layers *Known_Land_Supply* and *Primary_Land_Parcels_ LevelIII_Included* to create new data layer *Likely_Land_Supply_Base*

3. **Select** from *Likely_Land_Supply_Base* all polygons where with parcel_size ≤ *n* hectares and then **Reverse Selection** and then save new data layer as *Known_Land_Supply_n_or_more_ha*

4. Repeat Step 3 for $Area_{Min} \leq n \leq Area_{Max}$ in specified increments

Level IV – Restricted Land Supply

Regional councils identified the need to monitor the process of reverse sensitivity. In that process the "receiver" land use negatively experiences conditions generated by activities on an adjacent or neighbouring "source" land use or uses. As a result, some activities in the source land use could be limited or banned or, in the extreme case, the source land use is banned entirely. The guidelines focus on how reverse sensitivity between diffuse/rural residential areas (receiver) and surrounding primary production (source) affects estimates of land supply for primary production.

The methods outline generic steps to develop a series of progressively larger buffers around likely rural residential development and estimate the effect on land supply for primary production:

1. **Select** from *Primary_Land_Parcels_LevelIII_Included* all parcels ≤ *n* hectares in size and then **Save Selection** as new data layer *Restricted_Land_Supply_Parcels_ n_ha*

This step creates a new data layer consisting of parcels around which the buffers will be created. Increasing the size threshold will increase the number of parcels used to create the buffer and will likely increase the aggregate area of the buffers created, although the magnitude of the increase will vary spatially depending upon the configuration of parcels.

2. **Buffer***Restricted_Land_Supply_Parcels_ n_ha* to *mmm* meters to create new data layer *Restricted_Land_Supply_Parcels_ n_ha_mmm_meters_buffer*

Increasing the buffer distance will also likely increase the aggregate area of the buffers created.

3. **Union** *Known_Land_Supply_Base* and *Restricted_Land_Supply_Parcels_ n_ha_mmm_m_buffer data layers* to create new data layer *Restricted_Land_Supply_n_ha_mmm_meters*

The resulting data layer will create polygons that differentiate among areas inside and outside the specified buffer distance for parcels of a specified size threshold.

4.3 Monitoring and Reporting

The recommended indicators for monitoring and reporting the effects of land fragmentation are described below. The indicator set consists of three standard indicators (Land Supply, Number of Polygons, Size Distribution of Polygons) reported simultaneously across combinations of the four levels of analysis (I–IV) and two scales (region, class) (Table 4).

The value of indicators at the higher levels (I and II) and regional scale depend only on the data and methods used and will be standard and comparable among regions provided regional councils use the same data and methods outlined earlier.

Indicators at lower levels (III and IV) and all class indicators depend on specified parcel size thresholds (Levels III/IV), buffer distances (Level IV) or class(es) (Levels I–IV) of interest. Standardisation for those indicators for use across regions involves specifying recommended classes, parcels sizes, and buffer distances to use when calculating indicators. In that regard the set of indicators constitutes a minimum set of recommended indicators given the much larger potential range of options available.

At each level regional councils can also report optional area and shape indicators for individual polygons to reflect particular needs or circumstances. For example regions could track changes in the area and shape of a subsample of polygons in regional "hotspots" of land fragmentation (Hart et al. 2014) to help monitor the pace of change in those areas.

4.3.1 Indicator: Land Supply

Land Supply estimates the total land area currently available to primary production at each level of analysis.

It is calculated by summing the areas of all polygons. The general form of the equation is as follows:

$$LandSupply_{l,s} = \sum_{m=1}^{M} Area_m$$

where

l = level of analysis (I, II, III, IV)

s = scale of analysis (Region, Class)

$Area_m$ = area of polygon m in hectares

M = total number of polygons

Table 4 Recommended indicators for monitoring and reporting the effects of land fragmentation. Light grey shading highlights indicators

LEVEL I: MAXIMUM LAND SUPPLY		
Region: *Maximum Land Supply (hectares)* *Maximum Number of Polygons (scalar)* *Polygon Size Distribution (graph)*	*Class*: *Maximum Class Land Supply (hectares)* *Maximum Number of Class Polygons (scalar)* *Class Polygon Size Distribution (graph)*	*Polygons* (optional): *Polygon Area (hectares)* *Polygon Shape (area to perimeter ratio)*
LEVEL II: KNOWN LAND SUPPLY		
Region: Known Land Supply (hectares) Known Number of Polygons (scalar) Known Polygon Size Distribution (graph)	*Class*: Known Class Land Supply (hectares) Known Number of Class Polygons (scalar) Class Polygon Size Distribution (graph)	*Polygons* (optional): Polygon Area (hectares) Polygon Shape (area to perimeter ratio)
LEVEL III: LIKELY LAND SUPPLY		
Region: Likely Land Supply (hectares) Likely Number of Polygons (scalar) Polygon Size Distribution (graph)	*Class*: Likely Class Land Supply (hectares) Likely Number of Class Polygons (scalar) Class Polygon Size Distribution (graph)	*Polygons* (optional): Polygon Area (hectares) Polygon Shape (area to perimeter ratio)
LEVEL IV: RESTRICTED LAND SUPPLY		
Region: Restricted Land Supply (hectares) Number of Polygons (scalar) Polygon Size Distribution (graph)	*Class*: Restricted Class Land Supply (hectares) Number of Class Polygons (scalar) Class Polygon Size Distribution (graph)	*Polygons* (optional): Polygon Area (hectares) Polygon Shape (area to perimeter ratio)

Regional Land Supply

Regional land supply provides a general assessment of the consequences of land fragmentation, i.e. answers the key question of how much land remains available for primary production overall. It does not consider differences among land or soil capability or suitability or the requirements or limitations of any particular type of primary production. Given on-going development of urban areas, including rural residential development and designation of protected areas, collective monitoring will likely show a continued decrease in regional land supply over time.

Regional Maximum Land Supply and Known Land Supply are each a single value calculated by summing the areas of all polygons. For Likely and Restricted Land Supply the indicator value depends on parcel size threshold (Likely, Level III) and parcel size threshold and buffer distance (Restricted, Level IV).

For Likely Land Supply (Level III) standard reporting should provide estimates along a range of parcel size thresholds from 1 to 10 hectares in 1-hectare increments. A range of parcel size thresholds is recommended to a) span the likely range of rural residential property sizes, and

b) avoid disagreements regarding preferred parcel size threshold given the complexities of land fragmentation and differing regional council needs.

The 1–10 hectare range corresponds to the observed range of property sizes for a sample of 60 048 reported lifestyle blocks from the 2014 Agribase database (AssureQuality 2014) (Fig. 10). Because the methods specifying using all parcels less than or equal to the size threshold, increasing the size threshold will include progressively more of the area shown under the curve in Figure 10, up to the maximum of 10 hectares.

Agreeing a preferred individual estimate would be problematic given the complex nature of rural residential development and differing needs of regional councils. No single parcel-size threshold ideally reflects the effects of land fragmentation, e.g. variability in parcel size of rural residential development (Fig. 10). Also, as each regional council has its own needs, all councils would be unlikely to agree on a single preferred parcel size threshold.

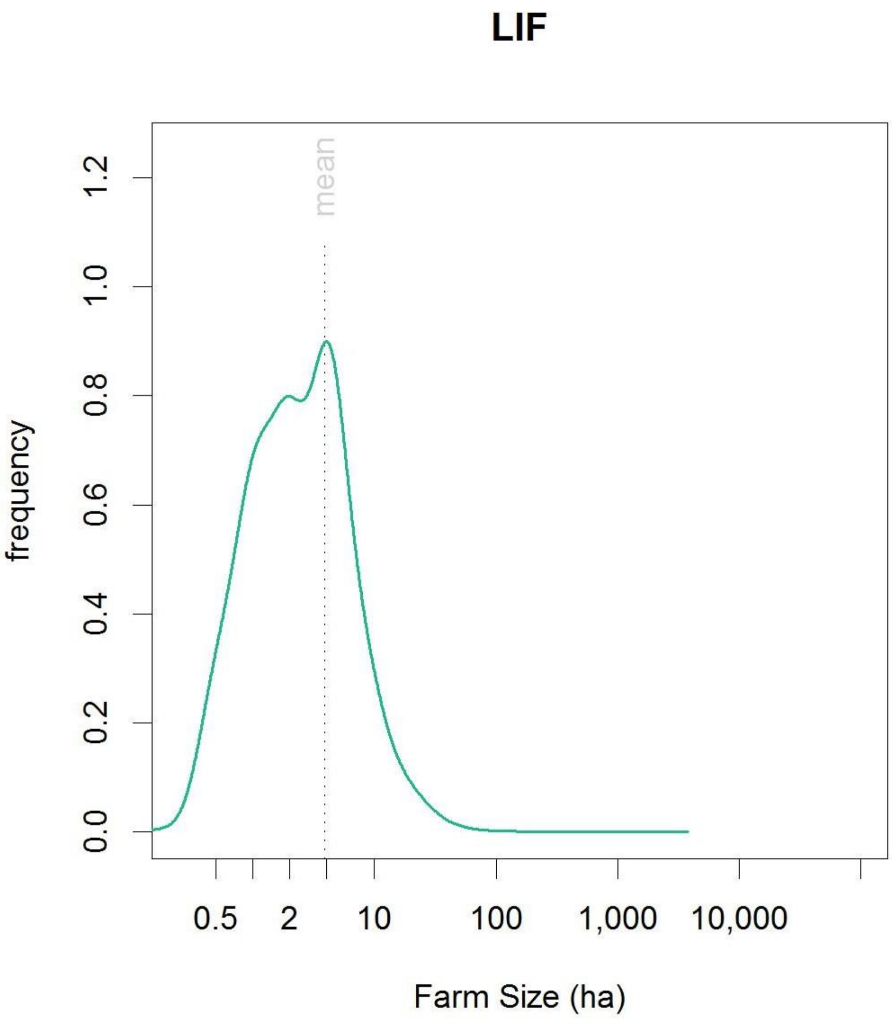

Figure 10 Size distribution of reported lifestyle blocks (LIF) from the Agribase 2014 database.

For Restricted Land Supply the recommendation is to buffer each of the 10 parcel-size thresholds (1–10 hectares) used for Likely Land Supply with a range of buffer distances from 50 to 250 m in 50-m increments. For the standard indicator, the receiver land use is “likely rural residential development" and the source land use is any land use within the delineated buffers.

The rationale for using the range of buffer distances is similar to that for the range of parcel-size thresholds. The recommended buffer distances provide a common set of indicator values that regional councils can use collectively to assess broad trends or can use in a targeted manner to address specific questions. In the former case, councils could for example report the areas of primary production remaining outside the buffer zone(s), i.e. the areas not currently at risk from reverse sensitivity effects. In the latter case, a council could, for example, create a spatial mask based on the 150-m buffer zone and identify areas of source land uses at risk from causing reverse sensitivity effects.

Being closely related, Likely Land Supply and Restricted Land Supply indicators can be reported together in tabular format as shown in Table 5.

Table 5 Sample table for reporting Likely and Restricted Land Supply indicators

Parcel Size Threshold (ha)	Likely Land Supply (ha)	Restricted Land Supply (ha) Buffer Distance (m)				
		50	100	150	200	250
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Class Land Supply

Class land supply complements regional land supply by providing more targeted monitoring of the effects of land fragmentation. It estimates the area available for primary production considering one or more specific factors, e.g. land-use capability, soil type(s), type(s) of primary production, or combinations thereof. Given the potential data sources available, the range of potential factors to include either individually in combination is large.

During guideline development extensive discussions occurred regarding what factors to monitor when considering the effects of land fragmentation. The most frequent topics are centred on monitoring the effects on key land resources such as "versatile soils," "high capability land," "high value land," etc. Overall, the discussions highlighted the difficulty in trying to agree a common definition and outline methods to operationalise such concepts given the variability in regional council priorities and needs and lead to the design recommendation to avoid the use and application of such terminology if possible.

Nonetheless, regional councils would benefit collectively from some standardisation of reporting in this regard. The guidelines therefore recommend reporting class indictors that track land supply for primary production for each of the eight land use capability (LUC) classes in the Land Resource Inventory at each level of analysis (I–IV). Land-use capability continues to be one of the most commonly used classifications to classify and quantify trends in land resources nationally (Rutledge et al. 2010; Andrews & Dymond 2012). Using the LUC has several advantages, including being part of an existing public data set and continuity with previous research.

Calculating the indicators will require including a layer of LUC polygons to the union (Step 5) of the Maximum Land Supply methods. Land supply at each level of analysis can then be summed by LUC class (1–8). For Likely and Restricted Land Supply the recommendations are to use the same range of parcel size thresholds and buffer distances as for the regional land supply indicators.

4.3.2 Indicator: Number of Polygons

Number of polygons is the first of two indicators to help monitor the process of land fragmentation as opposed to its outcomes, i.e. land supply for primary production. The recommendation is to report number of polygons in tandem with the recommended set of land supply indicators, e.g. regional number of polygons, class number of polygons, etc., at each level of analysis and the size distribution of polygons described below.

In general, an increase in the number of polygons indicates that land fragmentation is occurring or continuing to occur. The magnitude of the increase will also help indicate the relative speed of land fragmentation once enough data exist to assess trends over time, e.g. what is relatively fast and what is relatively slow.

No change or small changes in the number of polygons indicate that land fragmentation is not occurring or perhaps is currently stable.

A decrease in the number of polygons can be more difficult to interpret, given the methods used and varies somewhat by level. For Level I a decrease in number of polygons is unlikely, as the key networks delineating the polygons tend only to increase over time, especially transport networks. For Levels II–IV, the number of polygons could decrease if the number of polygons converted to non-primary production exceeds the number created by other processes, e.g. division of a primary production polygon into 2 or more polygons.

4.3.3 Indicator: Size Distribution of Polygons

Size distribution of polygons is the second of two indicators to help monitor the process of land fragmentation as opposed to its outcomes. It should be reported in tandem with land supply and number of parcels.

The indicator is reported as a graph of polygon size (x-axis) versus frequency (y-axis) similar to the graphs of farm size distribution (Figure 9) and lifestyle block distribution (Fig. 10).

Along with the number of polygons, shifts or changes in the shape of the distribution help indicate the magnitude and relative rate of land fragmentation. Leftward shifts or flattenings in the shape distribution indicate increasing land fragmentation as evidenced by larger numbers of smaller parcels. Minor changes to distribution may indicate relative stable conditions.

4.3.4 Optional Indicator: Polygon Area and Shape

Optional indicators related to the area and shape of individual polygons could be reported as circumstances warrant. Regional councils will need to explore the utility of such indicators to meet their individual needs and/or agree any standard reporting.

5 Acknowledgements

The authors acknowledge the Regional Council Land Monitoring Forum for taking the initiative that lead to development of the guidelines. Particular thanks go to Reece Hill (Waikato Regional Council) and Andrew Burton (Tasman District Council), who served as project champions and co-chairs of the project steering group. Fiona Curran-Cournane (Auckland Regional Council), Haydon Jones (Waikato Regional Council), and Dan Borman (Waikato Regional Council) also served in the project Steering Group and offered excellent ideas, advice and support throughout. Haydon also provided on-going support for organising workshops and presentations about the project to various Land Monitoring Forum meetings. The authors also thank Sam Carrick and Chris Phillips for their reviews and Anne Austin for her usual excellent editing.

6 References

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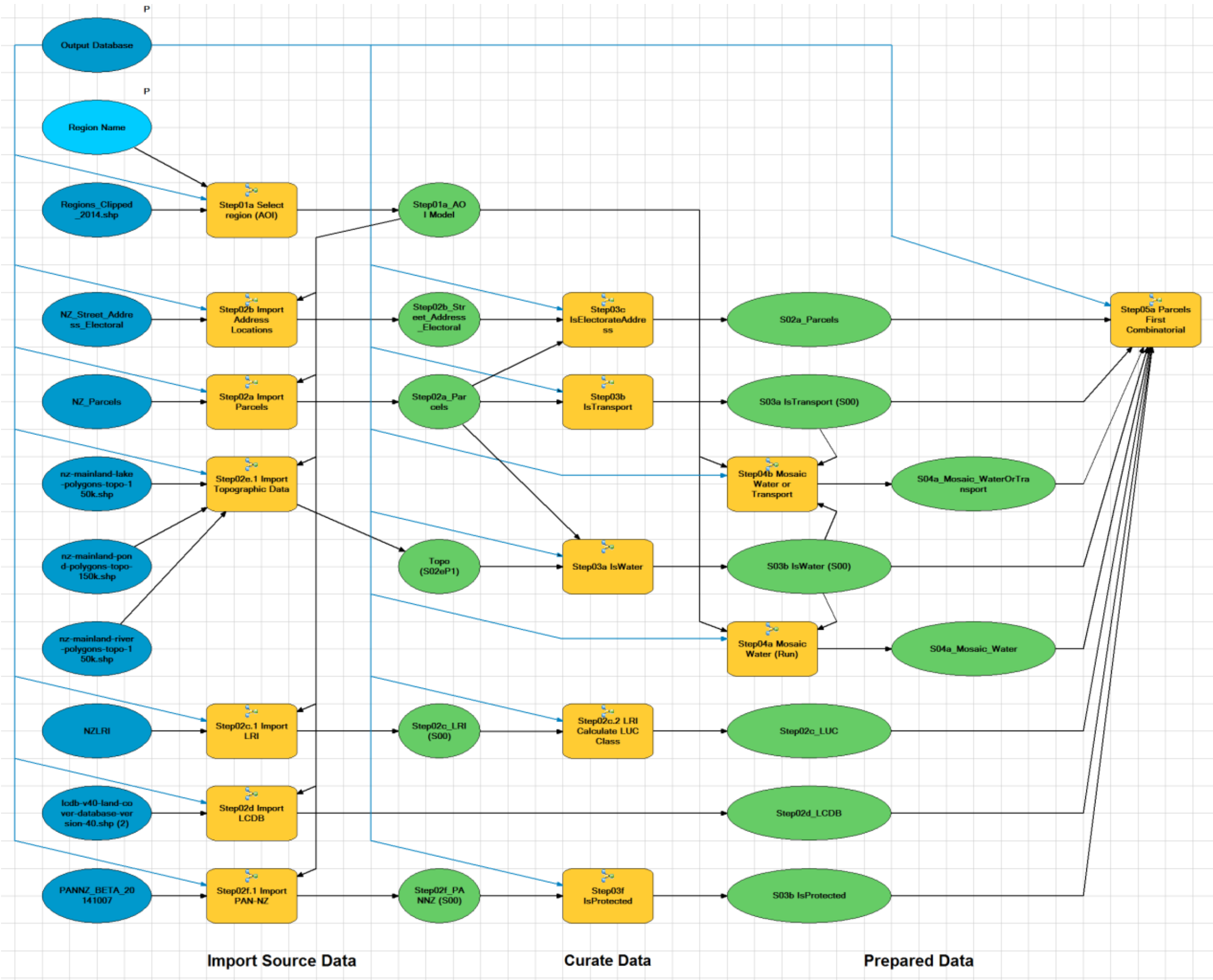
Appendix 1 – Example ESRI ArcGIS Modelbuilder Models and Python Code

Regional Land Fragmentation Analysis Model

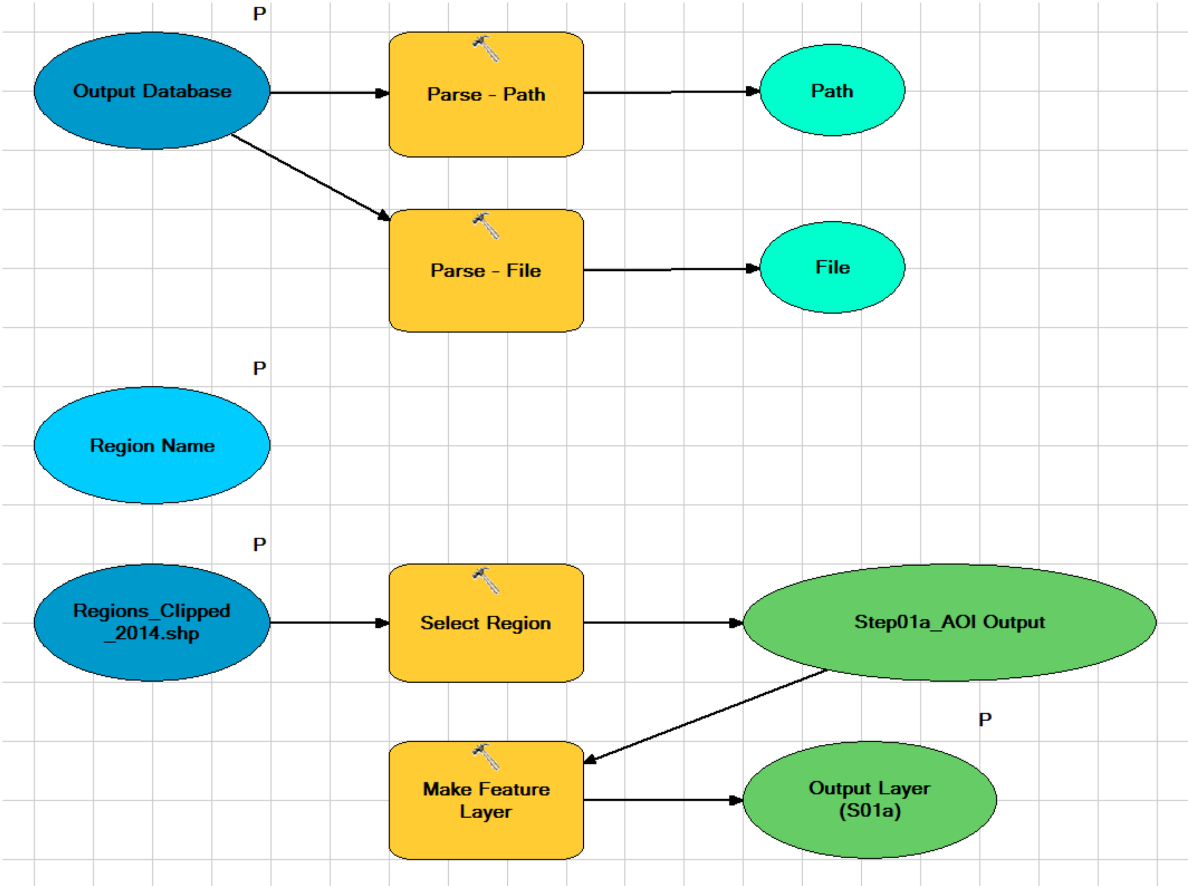



```
# ---------------------------------------------------------------------------
# S00.py
# Created on: 2014-12-05 10:49:47.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S00 <Output_Database> <Region_Name>
# Description:
# Runs the complete process from Importing all the data sets to running the Union of the
datasets.
# ---------------------------------------------------------------------------

# Set the necessary product code
# import arcinfo


# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("P:/Projects/SL1312_LandFragmentation/Data/Databases/ESRI/SL1312_Guideline
s_V03_Development.gdb/SL1312_DataPreprocessing")

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified
```

```
Region_Name = arcpy.GetParameterAsText(1)
if Region_Name == '#' or not Region_Name:
    Region_Name = "Test AOI" # provide a default value if unspecified

# Local variables:
Step02b_Street_Address_Electoral__S00_ = Output_Database
S02a_Parcels = Step02b_Street_Address_Electoral__S00_
Step02c_LUC = Output_Database
Step02d_LCDB = Output_Database
S03b_IsProtected = Output_Database
S04a_Mosaic_Water = Output_Database
Step02c_LRI__S00_ = Output_Database
Step02f_PANNZ__S00_ = Output_Database
Step01a_AOI_Model = Output_Database
S04a_Mosaic_WaterOrTransport = Step01a_AOI_Model
Step02a_Parcels = Step01a_AOI_Model
S03b_IsWater__S00_ = Step02a_Parcels
S03a_IsTransport__S00_ = Step02a_Parcels
Topo__S02eP1_ = Step01a_AOI_Model
NZ_Parcels =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\NZ_CRS_2014_06_28.gdb\\NZ_Parc
els"
NZ_Street_Address_Electoral =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\NZ_CRS_2014_06_28.gdb\\NZ_Stre
et_Address_Electoral"
Regions_Clipped_2014_shp =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\Regions_Clipped_2014.shp"
NZLRI = "N:\\Projects\\BaseData\\NZ\\LRI\\v2014\\NZLRI_20100525.gdb\\NZLRI"
PANNZ_BETA_20141007 = "N:\\Projects\\SL1416_RC_Indicator_M18LegalProtection\\Analysis\\PAN-
NZ_2014.gdb\\PANNZ_BETA_20141007"
lcdb-v40-land-cover-database-version-40_shp__2_ =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LCDB4\\lcdb-v40-land-cover-
database-version-40.shp"
nz-mainland-lake-polygons-topo-150k_shp =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LINZ_Topographic_2014\\nz-
mainland-lake-polygons-topo-150k\\nz-mainland-lake-polygons-topo-150k.shp"
nz-mainland-pond-polygons-topo-150k_shp =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LINZ_Topographic_2014\\nz-
mainland-pond-polygons-topo-150k\\nz-mainland-pond-polygons-topo-150k.shp"
nz-mainland-river-polygons-topo-150k_shp =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LINZ_Topographic_2014\\nz-
mainland-river-polygons-topo-150k\\nz-mainland-river-polygons-topo-150k.shp"

# Process: Step01a Select region (AOI)
arcpy.Step01aSelectRegionAOI_TBV03(Output_Database, Region_Name, Regions_Clipped_2014_shp,
Step01a_AOI_Model)

# Process: Step02a Import Parcels
arcpy.Step02aImportParcels_TBV03(Output_Database, NZ_Parcels, Step01a_AOI_Model,
Step02a_Parcels)

# Process: Step02b Import Address Locations
arcpy.Step02bImportAddressLocations_TBV03(Output_Database, NZ_Street_Address_Electoral,
Step02b_Street_Address_Electoral__S00_, Step01a_AOI_Model)

# Process: Step03c IsElectorateAddress
arcpy.Step03cIsElectorateAddress_TBV03(Output_Database, S02a_Parcels, Step02a_Parcels,
Step02b_Street_Address_Electoral__S00_)

# Process: Step02e.1 Import Topographic Data
arcpy.Step02eP1ImportTopographicData2_TBV03(Output_Database, Step01a_AOI_Model, nz-mainland-
lake-polygons-topo-150k_shp, nz-mainland-pond-polygons-topo-150k_shp, nz-mainland-river-
polygons-topo-150k_shp, Topo__S02eP1_)

# Process: Step03a IsWater
arcpy.Step03aIsWater_TBV03(Output_Database, Topo__S02eP1_, Step02a_Parcels,
S03b_IsWater__S00_)

# Process: Step04a Mosaic Water (Run)
arcpy.Step04MosaicWater_TBV03(Output_Database, S03b_IsWater__S00_, Step01a_AOI_Model,
S04a_Mosaic_Water)

# Process: Step03b IsTransport
arcpy.Step03bTransport_TBV03(Output_Database, S03a_IsTransport__S00_, Step02a_Parcels)

# Process: Step04b Mosaic Water or Transport
```

```
arcpy.Step04bMosaicWaterOrTransport_TBV03(Output_Database, S03a_IsTransport__S00_,
S03b_IsWater__S00_, Step01a_AOI_Model, S04a_Mosaic_WaterOrTransport)

# Process: Step02c.1 Import LRI
arcpy.Step02cP1ImportLRI_TBV03(Output_Database, Step01a_AOI_Model, Step02c_LRI__S00_, NZLRI)

# Process: Step02c.2 LRI Calculate LUC Class
arcpy.Step02cP2LRICalculateLUCClass_TBV03(Output_Database, Step02c_LRI__S00_, Step02c_LUC)

# Process: Step02d Import LCDB
arcpy.Step02dImportLCDB_TBV03(Output_Database, Step01a_AOI_Model, lcdb-v40-land-cover-
database-version-40_shp__2_, Step02d_LCDB)

# Process: Step02f.1 Import PAN-NZ
arcpy.Step02fImportPANNZ_TBV03(Output_Database, Step01a_AOI_Model, PANNZ_BETA_20141007,
Step02f_PANNZ__S00_)

# Process: Step03f IsProtected
arcpy.Step03fIsProtected_TBV03(Output_Database, Step02f_PANNZ__S00_, S03b_IsProtected)

# Process: Step05a Parcels First Combinatorial
arcpy.Step05aParcelsFirstCombinatorial_TBV03(Output_Database, S02a_Parcels, S04a_Mosaic_Water,
S04a_Mosaic_WaterOrTransport, Step02c_LUC, Step02d_LCDB, S03b_IsProtected,
S03a_IsTransport__S00_, S03b_IsWater__S00_)
```

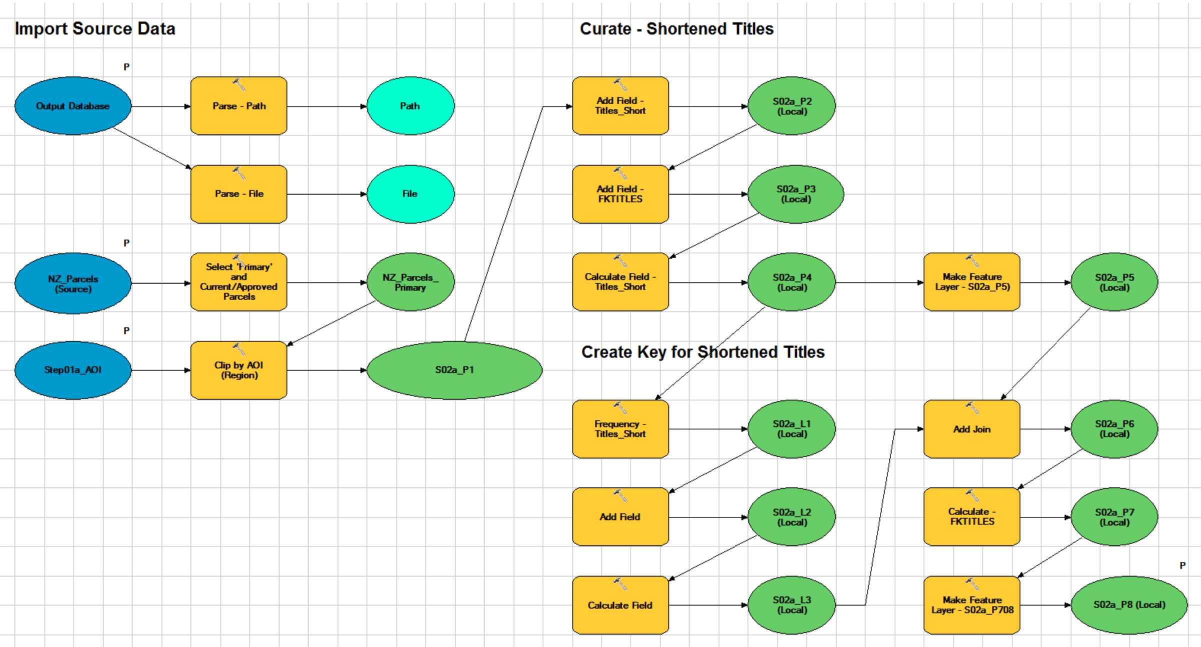
Step01a Select region (AOI)




```
# ---------------------------------------------------------------------------
# S01a.py
# Created on: 2014-12-05 10:50:01.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S01a <Output_Database> <Region_Name> <Regions_Clipped_2014_shp> <Output_Layer__S01a_>
# Description:
# Select the Region for the analysis.  Creates a region mask for the selected region which
will be used as an AOI in the subsequent analysis steps
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Region_Name = arcpy.GetParameterAsText(1)
if Region_Name == '#' or not Region_Name:
    Region_Name = "A Region" # provide a default value if unspecified
```

```
Regions_Clipped_2014_shp = arcpy.GetParameterAsText(2)
if Regions_Clipped_2014_shp == '#' or not Regions_Clipped_2014_shp:
    Regions_Clipped_2014_shp = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\Regions_Clipped_2014.shp" # 
provide a default value if unspecified

Output_Layer__S01a_ = arcpy.GetParameterAsText(3)
if Output_Layer__S01a_ == '#' or not Output_Layer__S01a_:
    Output_Layer__S01a_ = "Output Layer (Local S01a)" # provide a default value if unspecified

# Local variables:
Step01a_AOI_Output = Regions_Clipped_2014_shp
Path = Output_Database
File = Output_Database

# Process: Select Region
arcpy.Select_analysis(Regions_Clipped_2014_shp, Step01a_AOI_Output, "\"REGC2014_N\" = '%Region 
Name%'")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step01a_AOI_Output, Output_Layer__S01a_, "", "", "OBJECTID_1 
OBJECTID_1 VISIBLE NONE;Shape Shape VISIBLE NONE;OBJECTID OBJECTID VISIBLE NONE;REGC2014 
REGC2014 VISIBLE NONE;REGC2014_N REGC2014_N VISIBLE NONE;SHAPE_Leng SHAPE_Leng VISIBLE 
NONE;SHAPE_Area SHAPE_Area VISIBLE NONE;Shape_length Shape_length VISIBLE NONE;Shape_area 
Shape_area VISIBLE NONE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")
```

Step02a Import Parcels

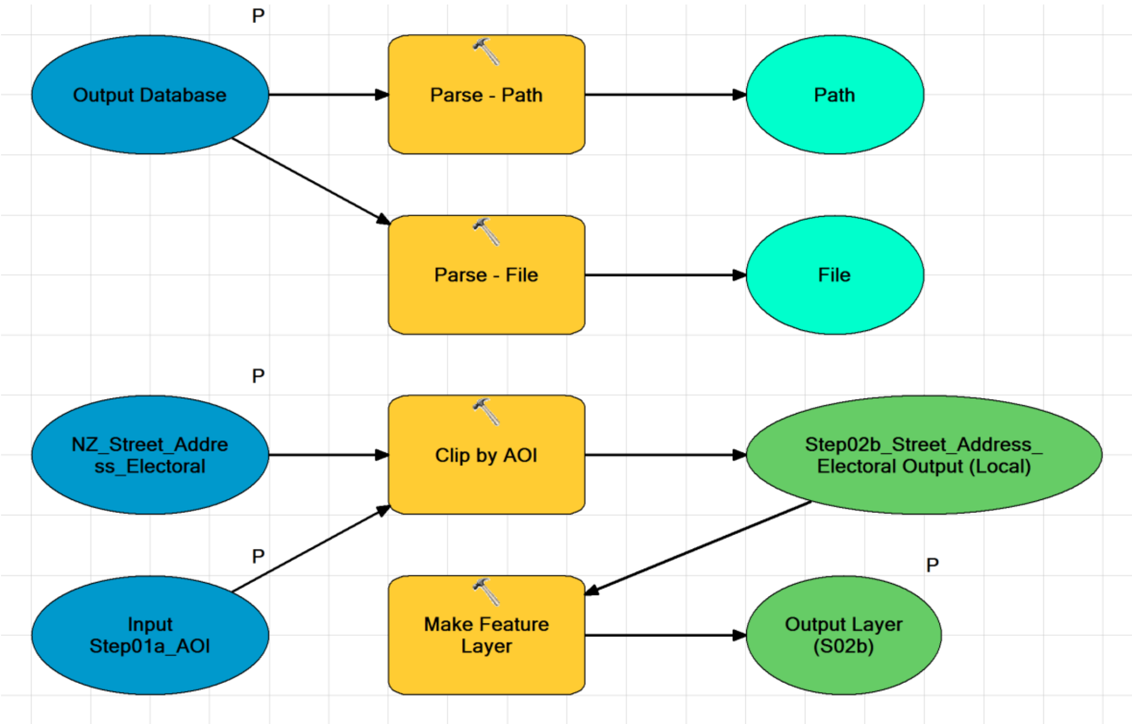



```
# ---------------------------------------------------------------------------
# S02a.py
# Created on: 2014-12-05 10:50:13.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02a <Output_Database> <NZ_Parcels__Source_> <Step01a_AOI> <S02a_P8__Local_>
# Description:
# Gets the current LINZ Parcels (specied by user) for the AOI (Region).
# Creates a field that contains a trimmed copy of the Titles info.
# A numeric column (FKTITLES) containing the unique titular entity
# is then added and calculated.
# ---------------------------------------------------------------------------

# Set the necessary product code
# import arcinfo

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace = "%Path%\\%File%"
arcpy.env.workspace = "%Path%\\%File%"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

NZ_Parcels__Source_ = arcpy.GetParameterAsText(1)
if NZ_Parcels__Source_ == '#' or not NZ_Parcels__Source_:
    NZ_Parcels__Source_ =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\NZ_CRS_2014_06_28.gdb\\NZ_Parc
els" # provide a default value if unspecified

Step01a_AOI = arcpy.GetParameterAsText(2)
if Step01a_AOI == '#' or not Step01a_AOI:
    Step01a_AOI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

S02a_P8__Local_ = arcpy.GetParameterAsText(3)
```

```
if S02a_P8__Local_ == '#' or not S02a_P8__Local_:
    S02a_P8__Local_ = "S02a_P8 (Local)" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
NZ_Parcels_Primary = NZ_Parcels__Source_
S02a_P1 = NZ_Parcels_Primary
S02a_P2__Local_ = S02a_P1
S02a_P3__Local_ = S02a_P2__Local_
S02a_P4__Local_ = S02a_P3__Local_
S02a_L1__Local_ = S02a_P4__Local_
S02a_L2__Local_ = S02a_L1__Local_
S02a_L3__Local_ = S02a_L2__Local_
S02a_P6__Local_ = S02a_L3__Local_
S02a_P7__Local_ = S02a_P6__Local_
S02a_P5__Local_ = S02a_P4__Local_

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Select 'Primary' and Current/Approved Parcels
arcpy.Select_analysis(NZ_Parcels__Source_, NZ_Parcels_Primary, "topology_type = 'Primary' AND
( status = 'Current' OR status = 'Approved as to Survey')")

# Process: Clip by AOI (Region)
arcpy.Clip_analysis(NZ_Parcels_Primary, Step01a_AOI, S02a_P1, "")

# Process: Add Field - Titles_Short
arcpy.AddField_management(S02a_P1, "Titles_Short", "TEXT", "", "", "254", "", "NULLABLE",
"NON_REQUIRED", "")

# Process: Add Field - FKTITLES
arcpy.AddField_management(S02a_P2__Local_, "FKTITLES", "LONG", "", "", "254", "", "NULLABLE",
"NON_REQUIRED", "")

# Process: Calculate Field - Titles_Short
arcpy.CalculateField_management(S02a_P3__Local_, "Titles_Short", "Left( [titles]+Space(200),
200)", "VB", "")

# Process: Make Feature Layer - S02a_P5)
arcpy.MakeFeatureLayer_management(S02a_P4__Local_, S02a_P5__Local_, "", "", "OBJECTID OBJECTID
VISIBLE NONE;Shape Shape VISIBLE NONE;id id VISIBLE NONE;appellation appellation VISIBLE
NONE;affected_surveys affected_surveys VISIBLE NONE;parcel_intent parcel_intent VISIBLE
NONE;topology_type topology_type VISIBLE NONE;status status VISIBLE NONE;statutory_actions
statutory_actions VISIBLE NONE;land_district land_district VISIBLE NONE;titles titles VISIBLE
NONE;survey_area survey_area VISIBLE NONE;calc_area calc_area VISIBLE NONE;Shape_Length
Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE NONE;Titles_Short Titles_Short VISIBLE
NONE;FKTITLES FKTITLES VISIBLE NONE")

# Process: Frequency - Titles_Short
arcpy.Frequency_analysis(S02a_P4__Local_, S02a_L1__Local_, "Titles_Short", "")

# Process: Add Field
arcpy.AddField_management(S02a_L1__Local_, "FKTITLES", "LONG", "", "", "", "", "NULLABLE",
"NON_REQUIRED", "")

# Process: Calculate Field
arcpy.CalculateField_management(S02a_L2__Local_, "FKTITLES", "[OBJECTID]", "VB", "")

# Process: Add Join
arcpy.AddJoin_management(S02a_P5__Local_, "Titles_Short", S02a_L3__Local_, "Titles_Short",
"KEEP_ALL")

# Process: Calculate - FKTITLES
arcpy.CalculateField_management(S02a_P6__Local_, "FKTITLES",
"[Step02a_Lookup_Titles.FKTITLES]", "VB", "")

# Process: Make Feature Layer - S02a_P708
arcpy.MakeFeatureLayer_management(S02a_P7__Local_, S02a_P8__Local_, "", "",
"Step02a_Parcels.OBJECTID Step02a_Parcels.OBJECTID VISIBLE NONE;Shape Shape VISIBLE
NONE;Step02a_Parcels.id Step02a_Parcels.id VISIBLE NONE;Step02a_Parcels.appellation
Step02a_Parcels.appellation VISIBLE NONE;Step02a_Parcels.affected_surveys
Step02a_Parcels.affected_surveys VISIBLE NONE;Step02a_Parcels.parcel_intent
```

```
Step02a_Parcels.parcel_intent VISIBLE NONE;Step02a_Parcels.topology_type
Step02a_Parcels.topology_type VISIBLE NONE;Step02a_Parcels.status Step02a_Parcels.status
VISIBLE NONE;Step02a_Parcels.statutory_actions Step02a_Parcels.statutory_actions VISIBLE
NONE;Step02a_Parcels.land_district Step02a_Parcels.land_district VISIBLE
NONE;Step02a_Parcels.titles Step02a_Parcels.titles VISIBLE NONE;Step02a_Parcels.survey_area
Step02a_Parcels.survey_area VISIBLE NONE;Step02a_Parcels.calc_area Step02a_Parcels.calc_area
VISIBLE NONE;Step02a_Parcels.Titles_Short Step02a_Parcels.Titles_Short VISIBLE
NONE;Step02a_Parcels.FKTITLES Step02a_Parcels.FKTITLES VISIBLE
NONE;Step02a_Lookup_Titles.FREQUENCY Step02a_Lookup_Titles.FREQUENCY VISIBLE
NONE;Step02a_Lookup_Titles.Titles_Short Step02a_Lookup_Titles.Titles_Short VISIBLE
NONE;Step02a_Lookup_Titles.FKTITLES Step02a_Lookup_Titles.FKTITLES VISIBLE NONE")
```

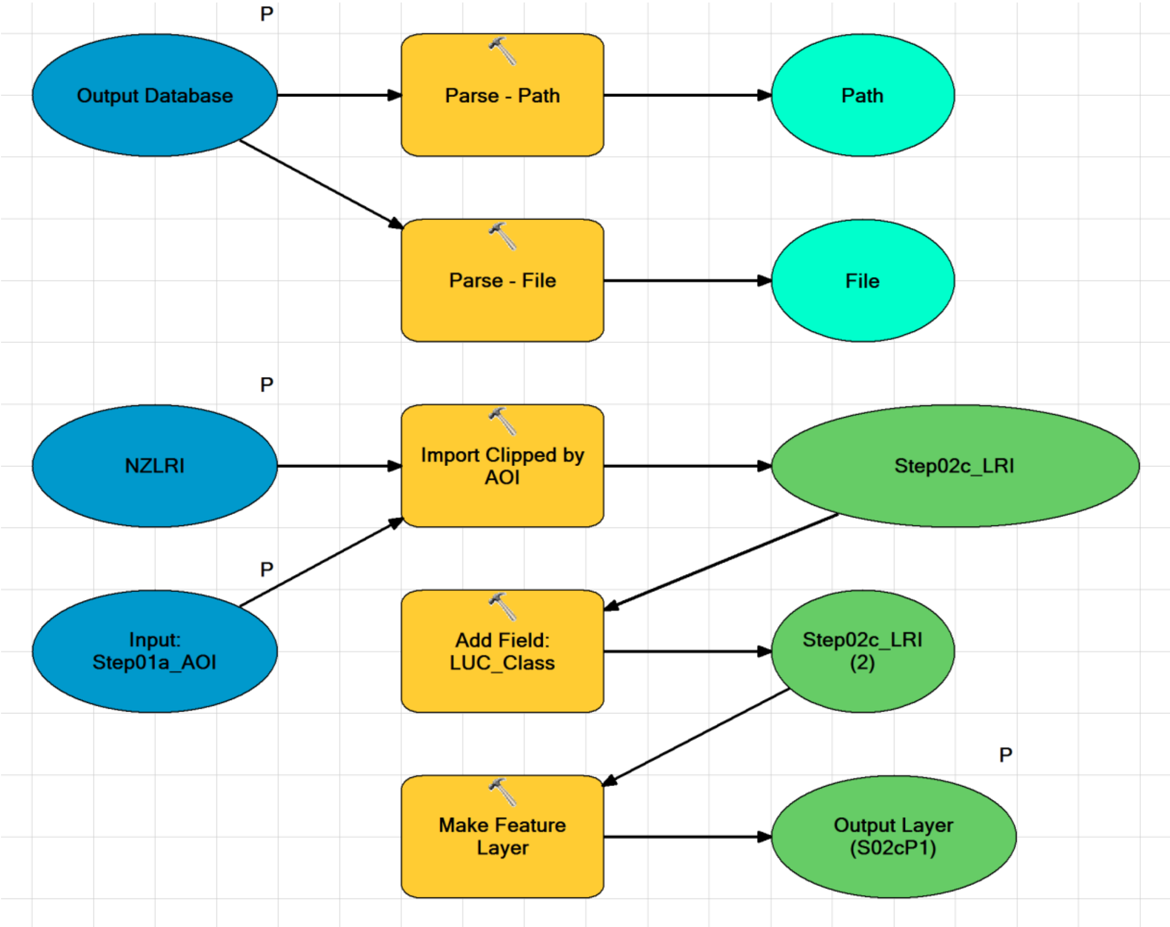
Step02b Import Address Locations




```
# ---------------------------------------------------------------------------
# S02b.py
# Created on: 2014-12-05 10:50:24.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02b <Output_Database> <NZ_Street_Address_Electoral> <Output_Layer__S02b_>
# <Input_Step01a_AOI>
# Description:
# Imports the LINZ Electorate Address (user specified) data for the selected Region (AOI).
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace = "%Path%\\%File%"
arcpy.env.workspace = "%Path%\\%File%"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

NZ_Street_Address_Electoral = arcpy.GetParameterAsText(1)
if NZ_Street_Address_Electoral == '#' or not NZ_Street_Address_Electoral:
    NZ_Street_Address_Electoral =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\NZ_CRS_2014_06_28.gdb\\NZ_Stre
et_Address_Electoral" # provide a default value if unspecified

Output_Layer__S02b_ = arcpy.GetParameterAsText(2)
if Output_Layer__S02b_ == '#' or not Output_Layer__S02b_:
    Output_Layer__S02b_ = "Output Layer (S02b)" # provide a default value if unspecified

Input_Step01a_AOI = arcpy.GetParameterAsText(3)
if Input_Step01a_AOI == '#' or not Input_Step01a_AOI:
```

```
    Input_Step01a_AOI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02b_Street_Address_Electoral_Output__Local_ = NZ_Street_Address_Electoral

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Clip by AOI
arcpy.Clip_analysis(NZ_Street_Address_Electoral, Input_Step01a_AOI,
Step02b_Street_Address_Electoral_Output__Local_, "")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step02b_Street_Address_Electoral_Output__Local_,
Output_Layer__S02b_, "", "", "OBJECTID OBJECTID VISIBLE NONE;SHAPE SHAPE VISIBLE NONE;id id
VISIBLE NONE;rna_id rna_id VISIBLE NONE;rcl_id rcl_id VISIBLE NONE;address address VISIBLE
NONE;house_number house_number VISIBLE NONE;range_low range_low VISIBLE NONE;range_high
range_high VISIBLE NONE;road_name road_name VISIBLE NONE;locality locality VISIBLE
NONE;territorial_authority territorial_authority VISIBLE NONE")
```

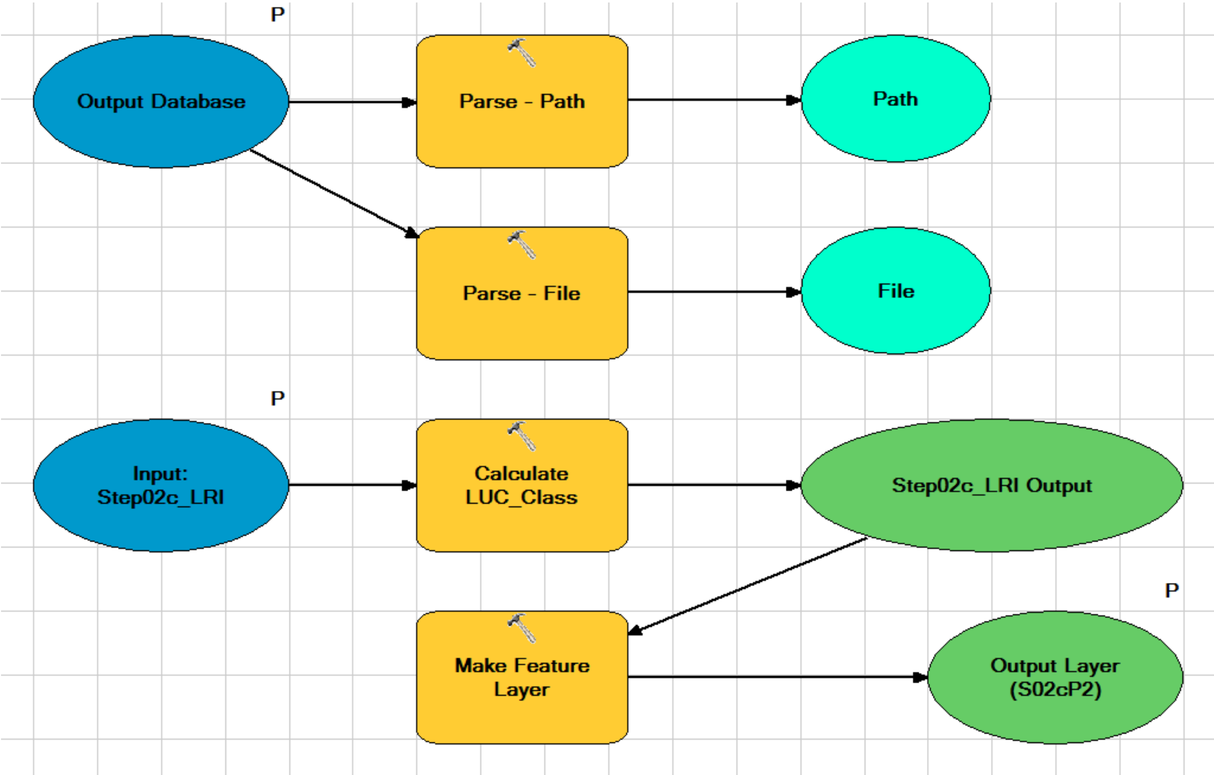
Step02c.1 Import LRI




```
# ---------------------------------------------------------------------------
# S02c1.py
# Created on: 2014-12-05 10:50:37.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02c1 <Output_Database> <Input__Step01a_AOI> <Output_Layer__S02cP1_> <NZLRI>
# Description:
# Imports the LRI (user specified) for specified AOI.
# Adds a field for the Land Use Capability value (this value is calculated in a S02c2).
# These two models do might be better merged into one.
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input__Step01a_AOI = arcpy.GetParameterAsText(1)
```

```
if Input__Step01a_AOI == '#' or not Input__Step01a_AOI:
    Input__Step01a_AOI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

Output_Layer__S02cP1_ = arcpy.GetParameterAsText(2)
if Output_Layer__S02cP1_ == '#' or not Output_Layer__S02cP1_:
    Output_Layer__S02cP1_ = "Output Layer(Local S01c1)" # provide a default value if
unspecified

NZLRI = arcpy.GetParameterAsText(3)
if NZLRI == '#' or not NZLRI:
    NZLRI = "N:\\Projects\\BaseData\\NZ\\LRI\\v2014\\NZLRI_20100525.gdb\\NZLRI" # provide a
default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02c_LRI = Input__Step01a_AOI
Step02c_LRI__2_ = Step02c_LRI

# Process: Import Clipped by AOI
arcpy.Clip_analysis(NZLRI, Input__Step01a_AOI, Step02c_LRI, "")

# Process: Add Field: LUC_Class
arcpy.AddField_management(Step02c_LRI, "LUC_Class", "SHORT", "", "", "", "", "NULLABLE",
"NON_REQUIRED", "")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step02c_LRI__2_, Output_Layer__S02cP1_, "", "", "OBJECTID
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;NILRI3 NILRI3 VISIBLE NONE;NILRI3_ID NILRI3_ID
VISIBLE NONE;LEGEND LEGEND VISIBLE NONE;LUC LUC VISIBLE NONE;LCORR LCORR VISIBLE NONE;ROCK
ROCK VISIBLE NONE;TOPROCK TOPROCK VISIBLE NONE;BASEROCK BASEROCK VISIBLE NONE;ROCK2 ROCK2
VISIBLE NONE;SURCODE SURCODE VISIBLE NONE;MAINSOIL MAINSOIL VISIBLE NONE;SOIL SOIL VISIBLE
NONE;SLOPE SLOPE VISIBLE NONE;EROSION EROSION VISIBLE NONE;VEG VEG VISIBLE NONE;VEG2 VEG2
VISIBLE NONE;CCAV CCAV VISIBLE NONE;CCTO CCTO VISIBLE NONE;CCPO CCPO VISIBLE NONE;PRSIR PRSIR
VISIBLE NONE;PRSIC PRSIC VISIBLE NONE;PRSIAV PRSIAV VISIBLE NONE;TYPE TYPE VISIBLE NONE;AREAH
AREAH VISIBLE NONE;EDITION EDITION VISIBLE NONE;POLYID POLYID VISIBLE NONE;Shape_Length
Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE NONE;SILRI3 SILRI3 VISIBLE
NONE;SILRI3_ID SILRI3_ID VISIBLE NONE;Shape_length Shape_length VISIBLE NONE;Shape_area
Shape_area VISIBLE NONE;LUC_Class LUC_Class VISIBLE NONE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")
```

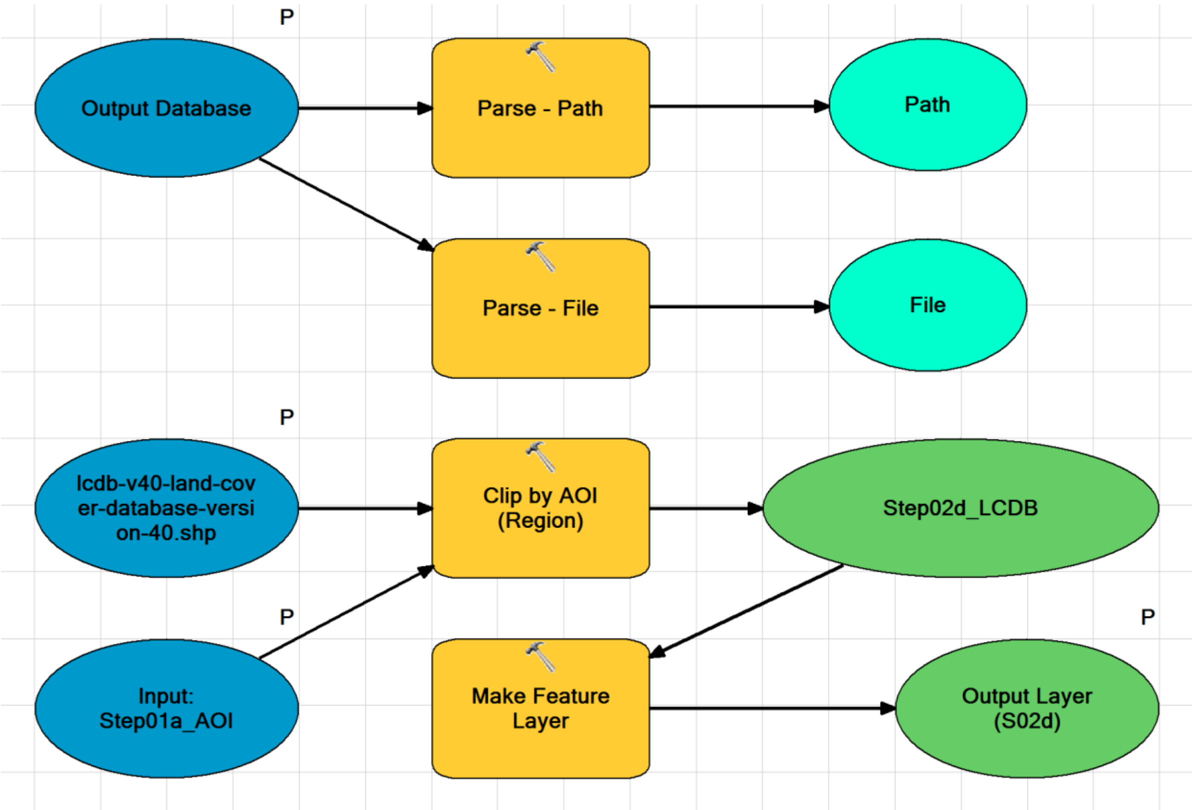
Step02c.2 LRI Calculate LUC Class




```
# ---------------------------------------------------------------------------
# S02c2.py
# Created on: 2014-12-05 10:50:52.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02c2 <Output_Database> <Input__Step02c_LRI> <Output_Layer__S02cP2_>
# Description:
# Populates a field with the LUC Class Code (1-8).
# This is taken from the [LCORR] field where the first character is numeric
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input__Step02c_LRI = arcpy.GetParameterAsText(1)
if Input__Step02c_LRI == '#' or not Input__Step02c_LRI:
    Input__Step02c_LRI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02c_LRI" # provide a default value if unspecified

Output_Layer__S02cP2_ = arcpy.GetParameterAsText(2)
if Output_Layer__S02cP2_ == '#' or not Output_Layer__S02cP2_:
```

```
    Output_Layer__S02cP2_ = "Output Layer (Local S02cP2)" # provide a default value if
unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02c_LRI_Output = Input__Step02c_LRI

# Process: Calculate LUC_Class
arcpy.CalculateField_management(Input__Step02c_LRI, "LUC_Class", "GetClass(!LCORR!)",
"PYTHON", "def GetClass(LUCCode):\\n    strL1 = LUCCode[0]\\n\\n    if ( strL1.isdigit()):\\n
return int( strL1)\\n    else:\\n        return None\\n")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step02c_LRI_Output, Output_Layer__S02cP2_, "", "", "OBJECTID
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;NILRI3 NILRI3 VISIBLE NONE;NILRI3_ID NILRI3_ID
VISIBLE NONE;LEGEND LEGEND VISIBLE NONE;LUC LUC VISIBLE NONE;LCORR LCORR VISIBLE NONE;ROCK
ROCK VISIBLE NONE;TOPROCK TOPROCK VISIBLE NONE;BASEROCK BASEROCK VISIBLE NONE;ROCK2 ROCK2
VISIBLE NONE;SURCODE SURCODE VISIBLE NONE;MAINSOIL MAINSOIL VISIBLE NONE;SOIL SOIL VISIBLE
NONE;SLOPE SLOPE VISIBLE NONE;EROSION EROSION VISIBLE NONE;VEG VEG VISIBLE NONE;VEG2 VEG2
VISIBLE NONE;CCAV CCAV VISIBLE NONE;CCTO CCTO VISIBLE NONE;CCPO CCPO VISIBLE NONE;PRSIR PRSIR
VISIBLE NONE;PRSIC PRSIC VISIBLE NONE;PRSIAV PRSIAV VISIBLE NONE;TYPE TYPE VISIBLE NONE;AREAH
AREAH VISIBLE NONE;EDITION EDITION VISIBLE NONE;POLYID POLYID VISIBLE NONE;SILRI3 SILRI3
VISIBLE NONE;SILRI3_ID SILRI3_ID VISIBLE NONE;Shape_Length Shape_Length VISIBLE
NONE;Shape_Area Shape_Area VISIBLE NONE;LUC_Class LUC_Class VISIBLE NONE")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")
```

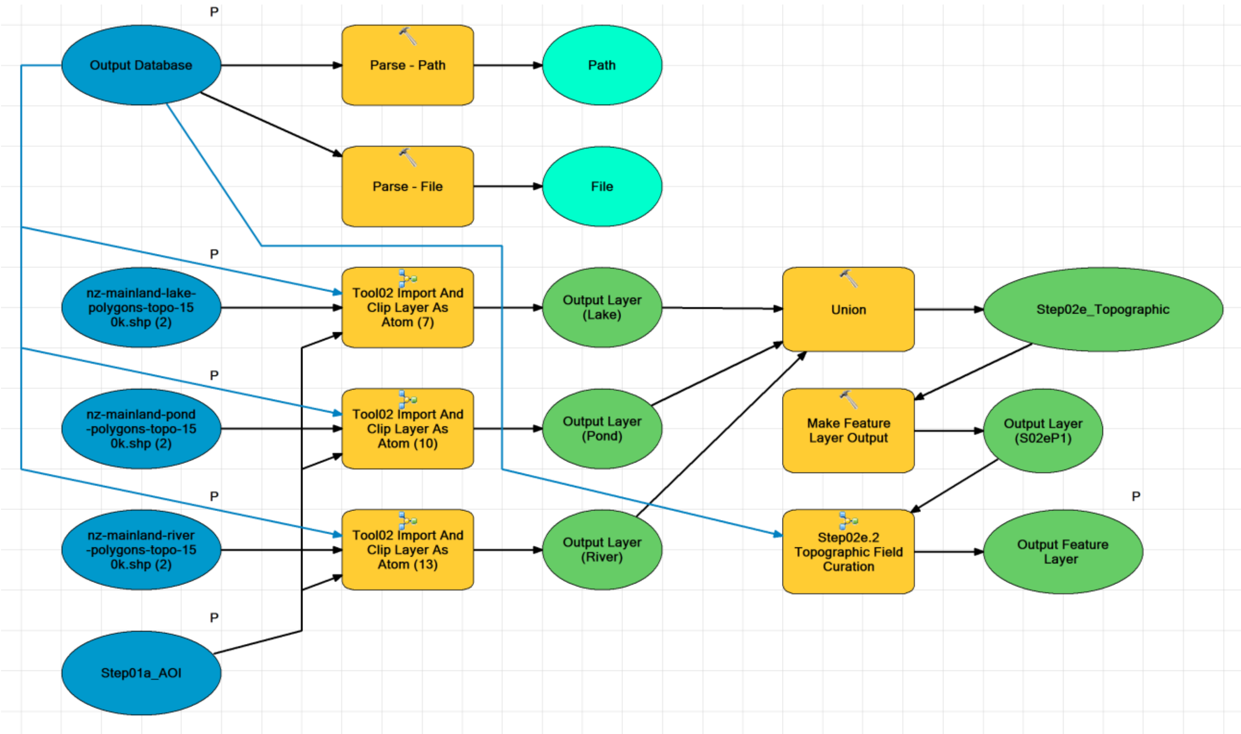
Step02d Import LCDB




```
# ---------------------------------------------------------------------------
# S02d.py
# Created on: 2014-12-05 10:51:05.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02d <Output_Database> <Input__Step01a_AOI>
#   <lcdb-v40-land-cover-database-version-40_shp> <Output_Layer__S02d_>
# Description:
# Imports the LCDB (user specified) for the region (AOI)
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input__Step01a_AOI = arcpy.GetParameterAsText(1)
if Input__Step01a_AOI == '#' or not Input__Step01a_AOI:
    Input__Step01a_AOI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

lcdb-v40-land-cover-database-version-40_shp = arcpy.GetParameterAsText(2)
```

```
if lcdb-v40-land-cover-database-version-40_shp == '#' or not lcdb-v40-land-cover-database-
version-40_shp:
    lcdb-v40-land-cover-database-version-40_shp =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LCDB4\\lcdb-v40-land-cover-
database-version-40.shp" # provide a default value if unspecified

Output_Layer__S02d_ = arcpy.GetParameterAsText(3)
if Output_Layer__S02d_ == '#' or not Output_Layer__S02d_:
    Output_Layer__S02d_ = "Output Layer (Local S02d)" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02d_LCDB = Input__Step01a_AOI

# Process: Clip by AOI (Region)
arcpy.Clip_analysis(lcdb-v40-land-cover-database-version-40_shp, Input__Step01a_AOI,
Step02d_LCDB, "")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step02d_LCDB, Output_Layer__S02d_, "", "", "OBJECTID
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;WET_CONTEX WET_CONTEX VISIBLE NONE;Onshore
Onshore VISIBLE NONE;LCDB_UID LCDB_UID VISIBLE NONE;EditDate EditDate VISIBLE NONE;EditAuthor
EditAuthor VISIBLE NONE;Class_1996 Class_1996 VISIBLE NONE;Class_2001 Class_2001 VISIBLE
NONE;Class_2008 Class_2008 VISIBLE NONE;Class_2012 Class_2012 VISIBLE NONE;Name_1996 Name_1996
VISIBLE NONE;Name_2001 Name_2001 VISIBLE NONE;Name_2008 Name_2008 VISIBLE NONE;Name_2012
Name_2012 VISIBLE NONE;Shape_length Shape_length VISIBLE NONE;Shape_area Shape_area VISIBLE
NONE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")
```

Step02e.1 Import Topographic Data




```
# ---------------------------------------------------------------------------
# S02e1.py
# Created on: 2014-12-05 10:51:17.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02e1 <Output_Database> <Step01a_AOI> <nz-mainland-lake-polygons-topo-150k_shp__2_>
<nz-mainland-pond-polygons-topo-150k_shp__2_> <nz-mainland-river-polygons-topo-150k_shp__2_>
<Output_Feature_Layer_>
# Description:
# Imports and preprocesses a the user specified water layers
# (Lake, River, Pond) from the LINZ Topographic dataset.
#  Adds a Binary field to each ( IsLake, IsRiver, IsPond)
#  Runs a union to create mask layer that is water.
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")
arcpy.ImportToolbox("P:/Projects/SL1312_LandFragmentation/Data/Databases/ESRI/SL1312_Guideline
s_V03_Development.gdb/SL1312_DataPreprocessing")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Step01a_AOI = arcpy.GetParameterAsText(1)
if Step01a_AOI == '#' or not Step01a_AOI:
```

```
    Step01a_AOI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

nz-mainland-lake-polygons-topo-150k_shp__2_ = arcpy.GetParameterAsText(2)
if nz-mainland-lake-polygons-topo-150k_shp__2_ == '#' or not nz-mainland-lake-polygons-topo-
150k_shp__2_:
    nz-mainland-lake-polygons-topo-150k_shp__2_ =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LINZ_Topographic_2014\\nz-
mainland-lake-polygons-topo-150k\\nz-mainland-lake-polygons-topo-150k.shp" # provide a default
value if unspecified

nz-mainland-pond-polygons-topo-150k_shp__2_ = arcpy.GetParameterAsText(3)
if nz-mainland-pond-polygons-topo-150k_shp__2_ == '#' or not nz-mainland-pond-polygons-topo-
150k_shp__2_:
    nz-mainland-pond-polygons-topo-150k_shp__2_ =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LINZ_Topographic_2014\\nz-
mainland-pond-polygons-topo-150k\\nz-mainland-pond-polygons-topo-150k.shp" # provide a default
value if unspecified

nz-mainland-river-polygons-topo-150k_shp__2_ = arcpy.GetParameterAsText(4)
if nz-mainland-river-polygons-topo-150k_shp__2_ == '#' or not nz-mainland-river-polygons-topo-
150k_shp__2_:
    nz-mainland-river-polygons-topo-150k_shp__2_ =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\GIS\\ShapeFiles\\LINZ_Topographic_2014\\nz-
mainland-river-polygons-topo-150k\\nz-mainland-river-polygons-topo-150k.shp" # provide a
default value if unspecified

Output_Feature_Layer_ = arcpy.GetParameterAsText(5)
if Output_Feature_Layer_ == '#' or not Output_Feature_Layer_:
    Output_Feature_Layer_ = "Output S02e2 " # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Output_Layer__Lake_ = Output_Database
Step02e_Topographic = Output_Layer__Lake_
Output_Layer__S02eP1_ = Step02e_Topographic
Output_Layer__Pond_ = Output_Database
Output_Layer__River_ = Output_Database

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Tool02 Import And Clip Layer As Atom (7)
arcpy.Tool01ImportAndClip2_TBV03(Output_Database, Output_Layer__Lake_, "Lake", Step01a_AOI,
nz-mainland-lake-polygons-topo-150k_shp__2_)

# Process: Tool02 Import And Clip Layer As Atom (10)
arcpy.Tool01ImportAndClip2_TBV03(Output_Database, Output_Layer__Pond_, "Pond", Step01a_AOI,
nz-mainland-pond-polygons-topo-150k_shp__2_)

# Process: Tool02 Import And Clip Layer As Atom (13)
arcpy.Tool01ImportAndClip2_TBV03(Output_Database, Output_Layer__River_, "River", Step01a_AOI,
nz-mainland-river-polygons-topo-150k_shp__2_)

# Process: Union
arcpy.Union_analysis("'Output Layer' #;'Output Layer (Pond)' #;'Output Layer (River)' #",
Step02e_Topographic, "ONLY_FID", "", "GAPS")

# Process: Make Feature Layer Output
arcpy.MakeFeatureLayer_management(Step02e_Topographic, Output_Layer__S02eP1_, "", "",
"OBJECTID OBJECTID VISIBLE NONE;FID_Temp_Step02e_Topo__ImportAs_
FID_Temp_Step02e_Topo__ImportAs_ VISIBLE NONE;Shape Shape VISIBLE
NONE;FID_Temp_Step02e_Topo__ImportAs1 FID_Temp_Step02e_Topo__ImportAs1 VISIBLE
NONE;FID_Temp_Step02e_Topo__ImportAs1_1 FID_Temp_Step02e_Topo__ImportAs1_1 VISIBLE
NONE;Shape_length Shape_length VISIBLE NONE;Shape_area Shape_area VISIBLE NONE")

# Process: Step02e.2 Topographic Field Curation
arcpy.Step02eP2TopographicFieldCuration2_TBV03(Output_Database, Output_Layer__S02eP1_,
Output_Feature_Layer_)
```

Step02e.1 Import Topographic Data


```
# ---------------------------------------------------------------------------
# S02e2.py
# Created on: 2014-12-05 10:51:30.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02e2 <Output_Database> <Input__Topographic_Data__S02E_> <Output_Layer__S02eP2_>
# Description:
# A bit dodgy, but renames fields and sets the values to Binary ( << 0 is 0, > 0 = 1)
# Called by S02e1
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("P:/Projects/SL1312_LandFragmentation/Data/Databases/ESRI/SL1312_Guideline
s_V03_Development.gdb/SL1312_DataPreprocessing")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
```

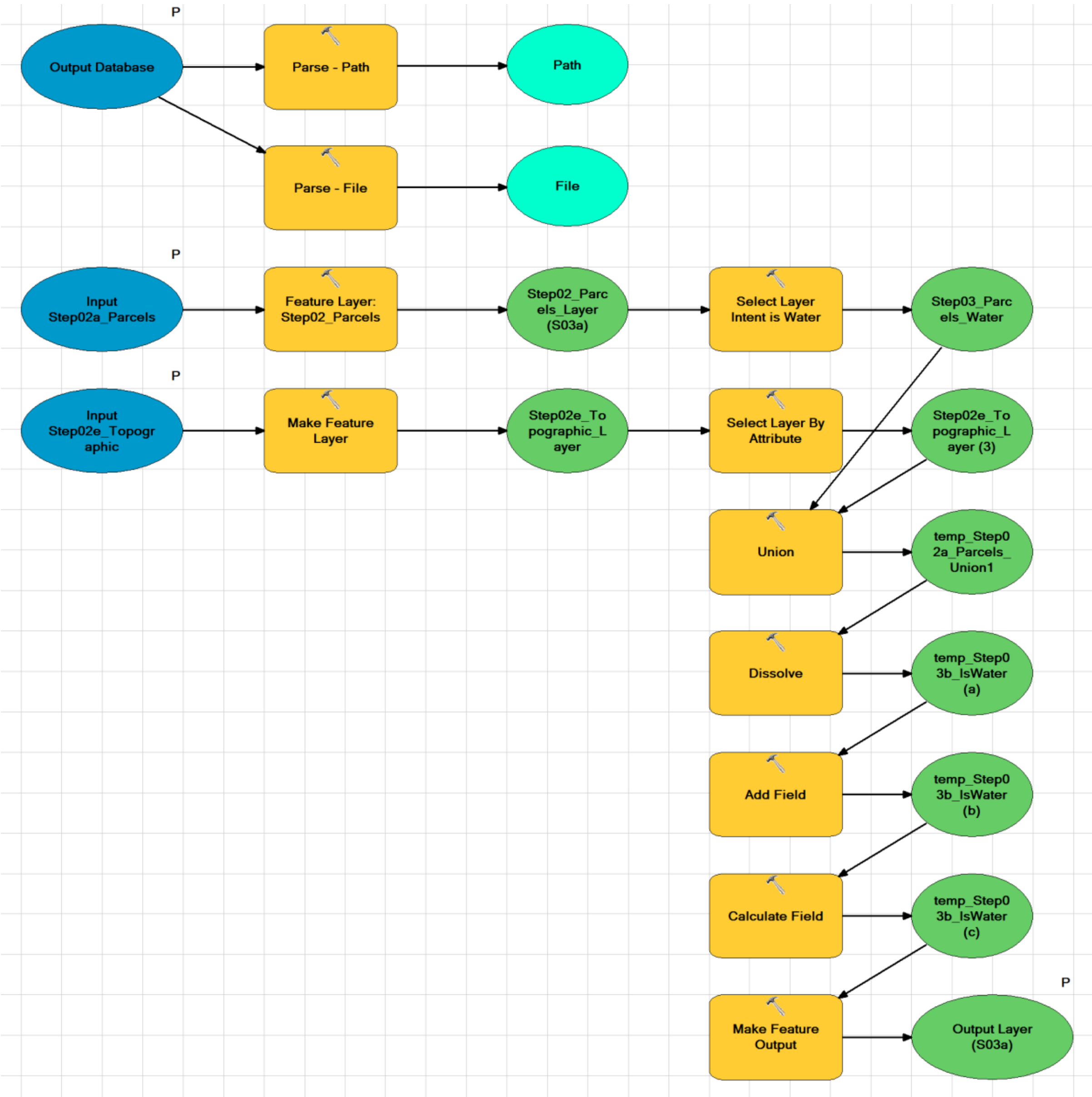
```
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input__Topographic_Data__S02E_ = arcpy.GetParameterAsText(1)
if Input__Topographic_Data__S02E_ == '#' or not Input__Topographic_Data__S02E_:
    Input__Topographic_Data__S02E_ =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02e_Topographic" # provide a default value if unspecified

Output_Layer__S02eP2_ = arcpy.GetParameterAsText(2)
if Output_Layer__S02eP2_ == '#' or not Output_Layer__S02eP2_:
    Output_Layer__S02eP2_ = "temp Output Layer " # provide a default value if unspecified

# Local variables:
temp_Step02_FieldAsBinary__P01___5_ = Input__Topographic_Data__S02E_
temp_Step02_FieldAsBinary__P01___8_ = Input__Topographic_Data__S02E_
temp_Step02_FieldAsBinary__P01___11_ = Input__Topographic_Data__S02E_

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Input__Topographic_Data__S02E_, Output_Layer__S02eP2_, "",
"", "OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;FID_Temp_Step02e_Topo_Airport
FID_Temp_Step02e_Topo_Airport VISIBLE NONE;FID_Temp_Step02e_Topo_Cemetry
FID_Temp_Step02e_Topo_Cemetry VISIBLE NONE;FID_Temp_Step02e_Topo_GolfCourse
FID_Temp_Step02e_Topo_GolfCourse VISIBLE NONE;FID_Temp_Step02e_Topo_GravelPit
FID_Temp_Step02e_Topo_GravelPit VISIBLE NONE;FID_Temp_Step02e_Topo_Lake
FID_Temp_Step02e_Topo_Lake VISIBLE NONE;FID_Temp_Step02e_Topo_Landfill
FID_Temp_Step02e_Topo_Landfill VISIBLE NONE;FID_Temp_Step02e_Topo_Mine
FID_Temp_Step02e_Topo_Mine VISIBLE NONE;FID_Temp_Step02e_Topo_Pond FID_Temp_Step02e_Topo_Pond
VISIBLE NONE;FID_Temp_Step02e_Topo_PumicePit FID_Temp_Step02e_Topo_PumicePit VISIBLE
NONE;FID_Temp_Step02e_Topo_ResidentialArea FID_Temp_Step02e_Topo_ResidentialArea VISIBLE
NONE;FID_Temp_Step02e_Topo_River FID_Temp_Step02e_Topo_River VISIBLE
NONE;FID_Temp_Step02e_Topo_Showground FID_Temp_Step02e_Topo_Showground VISIBLE
NONE;FID_Temp_Step02e_Topo_Building FID_Temp_Step02e_Topo_Building VISIBLE NONE;Shape_Length
Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE NONE;Airport Airport VISIBLE
NONE;Building Building VISIBLE NONE;Cemetry Cemetry VISIBLE NONE;Golfcourse Golfcourse VISIBLE
NONE;GravelPit GravelPit VISIBLE NONE;Lake Lake VISIBLE NONE;Landfill Landfill VISIBLE
NONE;Mine Mine VISIBLE NONE;Pond Pond VISIBLE NONE;PumicePit PumicePit VISIBLE
NONE;ResidentialArea ResidentialArea VISIBLE NONE;River River VISIBLE NONE;Showground
Showground VISIBLE NONE")

# Process: Tool02 Field As Binary (Lake)
arcpy.Tool01FieldAsBinary_TBV03("Lake", "FID_Temp_Step02e_Topo_Lake",
Input__Topographic_Data__S02E_)

# Process: Tool02 Field As Binary (Pond)
arcpy.Tool01FieldAsBinary_TBV03("Pond", "FID_Temp_Step02e_Topo_Pond",
Input__Topographic_Data__S02E_)

# Process: Tool02 Field As Binary (River)
arcpy.Tool01FieldAsBinary_TBV03("River", "FID_Temp_Step02e_Topo_River",
Input__Topographic_Data__S02E_)
```

Step02f.1 Import PAN-NZ


```
# ---------------------------------------------------------------------------
# S02f.py
# Created on: 2014-12-05 10:51:42.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S02f <Output_Database> <Input__Step01a_AOI>
#    <PANNZ_BETA_20141007> <Output_Layer__S0fP1_>
# Description:
# Imports the PAN-NZ (user specified)  dataset for the region (AOI).
# Creates a binary field isProtected to be used as a mask layer.
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
```

```
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input__Step01a_AOI = arcpy.GetParameterAsText(1)
if Input__Step01a_AOI == '#' or not Input__Step01a_AOI:
    Input__Step01a_AOI = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

PANNZ_BETA_20141007 = arcpy.GetParameterAsText(2)
if PANNZ_BETA_20141007 == '#' or not PANNZ_BETA_20141007:
    PANNZ_BETA_20141007 = 
"N:\\Projects\\SL1416_RC_Indicator_M18LegalProtection\\Analysis\\PAN-
NZ_2014.gdb\\PANNZ_BETA_20141007" # provide a default value if unspecified

Output_Layer__S0fP1_ = arcpy.GetParameterAsText(3)
if Output_Layer__S0fP1_ == '#' or not Output_Layer__S0fP1_:
    Output_Layer__S0fP1_ = "Output Layer(local S02f)" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02e_PANNZ = Input__Step01a_AOI
Step02e_PANNZ_AddField = Step02e_PANNZ
Step02e_PANNZ__3_ = Step02e_PANNZ_AddField

# Process: Clipby AOI (Region)
arcpy.Clip_analysis(PANNZ_BETA_20141007, Input__Step01a_AOI, Step02e_PANNZ, "")

# Process: Add Field: IsProtected
arcpy.AddField_management(Step02e_PANNZ, "IsProtected", "SHORT", "", "", "", "", "NULLABLE", 
"NON_REQUIRED", "")

# Process: Calculate Field
arcpy.CalculateField_management(Step02e_PANNZ_AddField, "IsProtected", "1", "VB", "")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step02e_PANNZ__3_, Output_Layer__S0fP1_, "", "", "OBJECTID 
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;StatusPhrase StatusPhrase VISIBLE 
NONE;MarginalStripFixed MarginalStripFixed VISIBLE NONE;ProvisionOfMarginalStrip 
ProvisionOfMarginalStrip VISIBLE NONE;ProvisionOfEsplanadeStrip ProvisionOfEsplanadeStrip 
VISIBLE NONE;FlagHasChange FlagHasChange VISIBLE NONE;FlagHasRevoke FlagHasRevoke VISIBLE 
NONE;Source Source VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Shape_Area Shape_Area 
VISIBLE NONE;Shape_length Shape_length VISIBLE NONE;Shape_area Shape_area VISIBLE 
NONE;IsProtected IsProtected VISIBLE NONE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")
```

Step03a IsWater

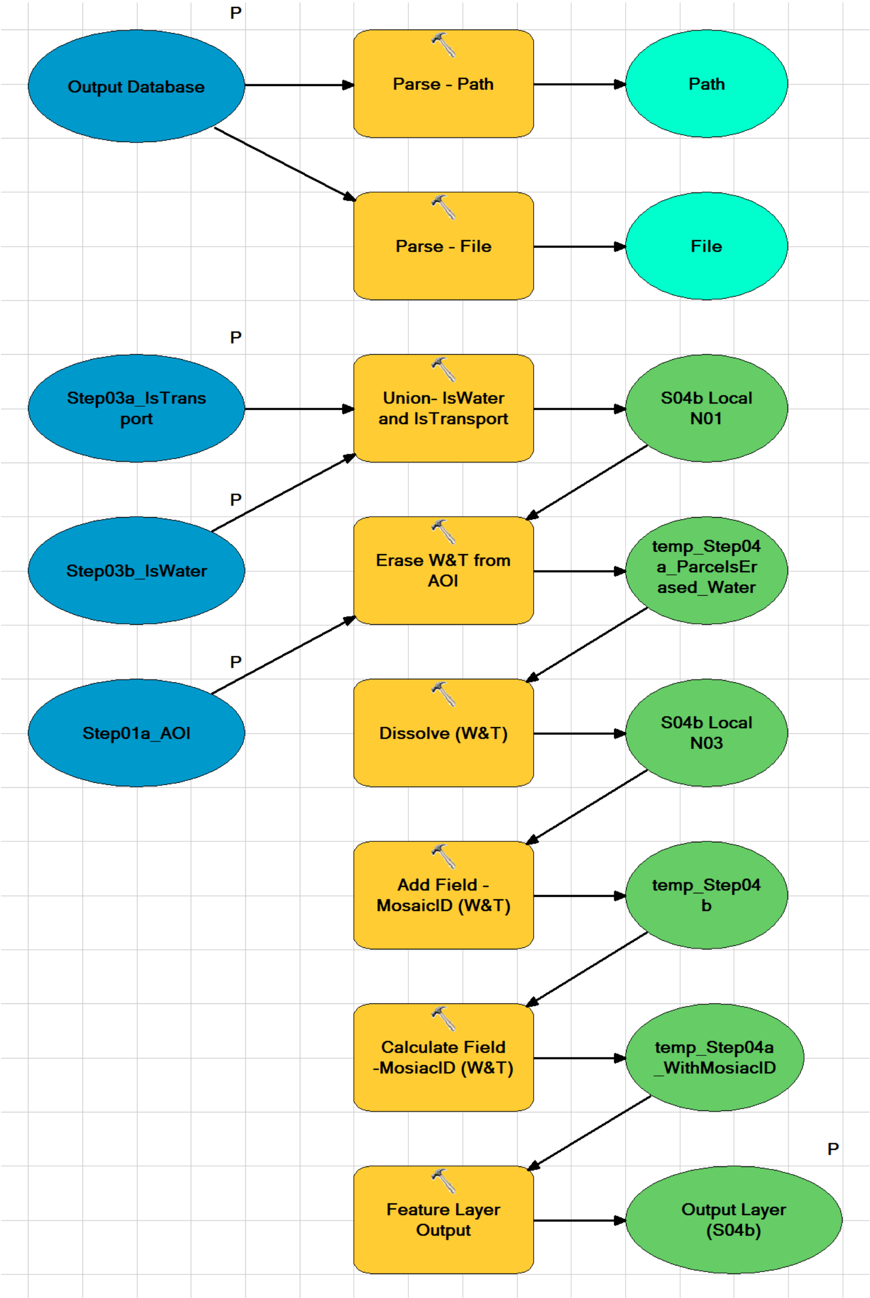



```
# ---------------------------------------------------------------------------
# S03a.py
# Created on: 2014-12-05 10:51:57.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S03a <Output_Database> <Input_Step02e_Topographic>
#  <Input_Step02a_Parcels> <Output_Layer__S03a_>
# Description:
# Creates a binary Mask for water based on the Topogrpahic data
# (the Topographic import was designed to allow, more masks of this type to be built but these
# have not been recommended at this stage)
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace = "%Path%\\%File%"
arcpy.env.workspace = "%Path%\\%File%"
```

```
# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input_Step02e_Topographic = arcpy.GetParameterAsText(1)
if Input_Step02e_Topographic == '#' or not Input_Step02e_Topographic:
    Input_Step02e_Topographic =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02e_Topographic" # provide a default value if unspecified

Input_Step02a_Parcels = arcpy.GetParameterAsText(2)
if Input_Step02a_Parcels == '#' or not Input_Step02a_Parcels:
    Input_Step02a_Parcels =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02a_Parcels" # provide a default value if unspecified

Output_Layer__S03a_ = arcpy.GetParameterAsText(3)
if Output_Layer__S03a_ == '#' or not Output_Layer__S03a_:
    Output_Layer__S03a_ = "Output Layer (Local S03a)" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02_Parcels_Layer__S03a_ = Input_Step02a_Parcels
Step03_Parcels_Water = Step02_Parcels_Layer__S03a_
temp_Step02a_Parcels_Union1 = Step03_Parcels_Water
temp_Step03b_IsWater__a_ = temp_Step02a_Parcels_Union1
temp_Step03b_IsWater__b_ = temp_Step03b_IsWater__a_
temp_Step03b_IsWater__c_ = temp_Step03b_IsWater__b_
Step02e_Topographic_Layer = Input_Step02e_Topographic
Step02e_Topographic_Layer__3_ = Step02e_Topographic_Layer

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Input_Step02e_Topographic, Step02e_Topographic_Layer, "",
"", "OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;FID_Temp_Step02e_Topo_Airport
FID_Temp_Step02e_Topo_Airport VISIBLE NONE;FID_Temp_Step02e_Topo_Cemetry
FID_Temp_Step02e_Topo_Cemetry VISIBLE NONE;FID_Temp_Step02e_Topo_GolfCourse
FID_Temp_Step02e_Topo_GolfCourse VISIBLE NONE;FID_Temp_Step02e_Topo_GravelPit
FID_Temp_Step02e_Topo_GravelPit VISIBLE NONE;FID_Temp_Step02e_Topo_Lake
FID_Temp_Step02e_Topo_Lake VISIBLE NONE;FID_Temp_Step02e_Topo_Landfill
FID_Temp_Step02e_Topo_Landfill VISIBLE NONE;FID_Temp_Step02e_Topo_Mine
FID_Temp_Step02e_Topo_Mine VISIBLE NONE;FID_Temp_Step02e_Topo_Pond FID_Temp_Step02e_Topo_Pond
VISIBLE NONE;FID_Temp_Step02e_Topo_PumicePit FID_Temp_Step02e_Topo_PumicePit VISIBLE
NONE;FID_Temp_Step02e_Topo_ResidentialArea FID_Temp_Step02e_Topo_ResidentialArea VISIBLE
NONE;FID_Temp_Step02e_Topo_River FID_Temp_Step02e_Topo_River VISIBLE
NONE;FID_Temp_Step02e_Topo_Showground FID_Temp_Step02e_Topo_Showground VISIBLE
NONE;FID_Temp_Step02e_Topo_Building FID_Temp_Step02e_Topo_Building VISIBLE NONE;Shape_Length
Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE NONE;Airport Airport VISIBLE
NONE;Building Building VISIBLE NONE;Cemetry Cemetry VISIBLE NONE;Golfcourse Golfcourse VISIBLE
NONE;GravelPit GravelPit VISIBLE NONE;Lake Lake VISIBLE NONE;Landfill Landfill VISIBLE
NONE;Mine Mine VISIBLE NONE;Pond Pond VISIBLE NONE;PumicePit PumicePit VISIBLE
NONE;ResidentialArea ResidentialArea VISIBLE NONE;River River VISIBLE NONE;Showground
Showground VISIBLE NONE")

# Process: Select Layer By Attribute
arcpy.SelectLayerByAttribute_management(Step02e_Topographic_Layer, "NEW_SELECTION", "Lake > -1
OR Pond > -1 OR River > -1")

# Process: Feature Layer: Step02_Parcels
arcpy.MakeFeatureLayer_management(Input_Step02a_Parcels, Step02_Parcels_Layer__S03a_, "", "",
"OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;id id VISIBLE NONE;appellation
appellation VISIBLE NONE;affected_surveys affected_surveys VISIBLE NONE;parcel_intent
parcel_intent VISIBLE NONE;topology_type topology_type VISIBLE NONE;status status VISIBLE
NONE;statutory_actions statutory_actions VISIBLE NONE;land_district land_district VISIBLE
NONE;titles titles VISIBLE NONE;survey_area survey_area VISIBLE NONE;calc_area calc_area
VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE
NONE;IsElectorateAddress IsElectorateAddress VISIBLE NONE")
```

```
# Process: Select Layer Intent is Water
arcpy.SelectLayerByAttribute_management(Step02_Parcels_Layer__S03a_, "NEW_SELECTION",
"parcel_intent =  'Hydro'\\nOR parcel_intent= 'Riverbed' \\nOR parcel_intent = 'Streambed'")

# Process: Union
arcpy.Union_analysis("Step02e_Topographic_Layer #;Step02a_Parcels_Layer #",
temp_Step02a_Parcels_Union1, "ALL", "", "GAPS")

# Process: Dissolve
arcpy.Dissolve_management(temp_Step02a_Parcels_Union1, temp_Step03b_IsWater__a_, "", "",
"SINGLE_PART", "DISSOLVE_LINES")

# Process: Add Field
arcpy.AddField_management(temp_Step03b_IsWater__a_, "IsWater", "SHORT", "", "", "", "",
"NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field
arcpy.CalculateField_management(temp_Step03b_IsWater__b_, "IsWater", "1", "VB", "")

# Process: Make Feature Output
arcpy.MakeFeatureLayer_management(temp_Step03b_IsWater__c_, Output_Layer__S03a_, "", "",
"IsWater IsWater VISIBLE NONE")
```

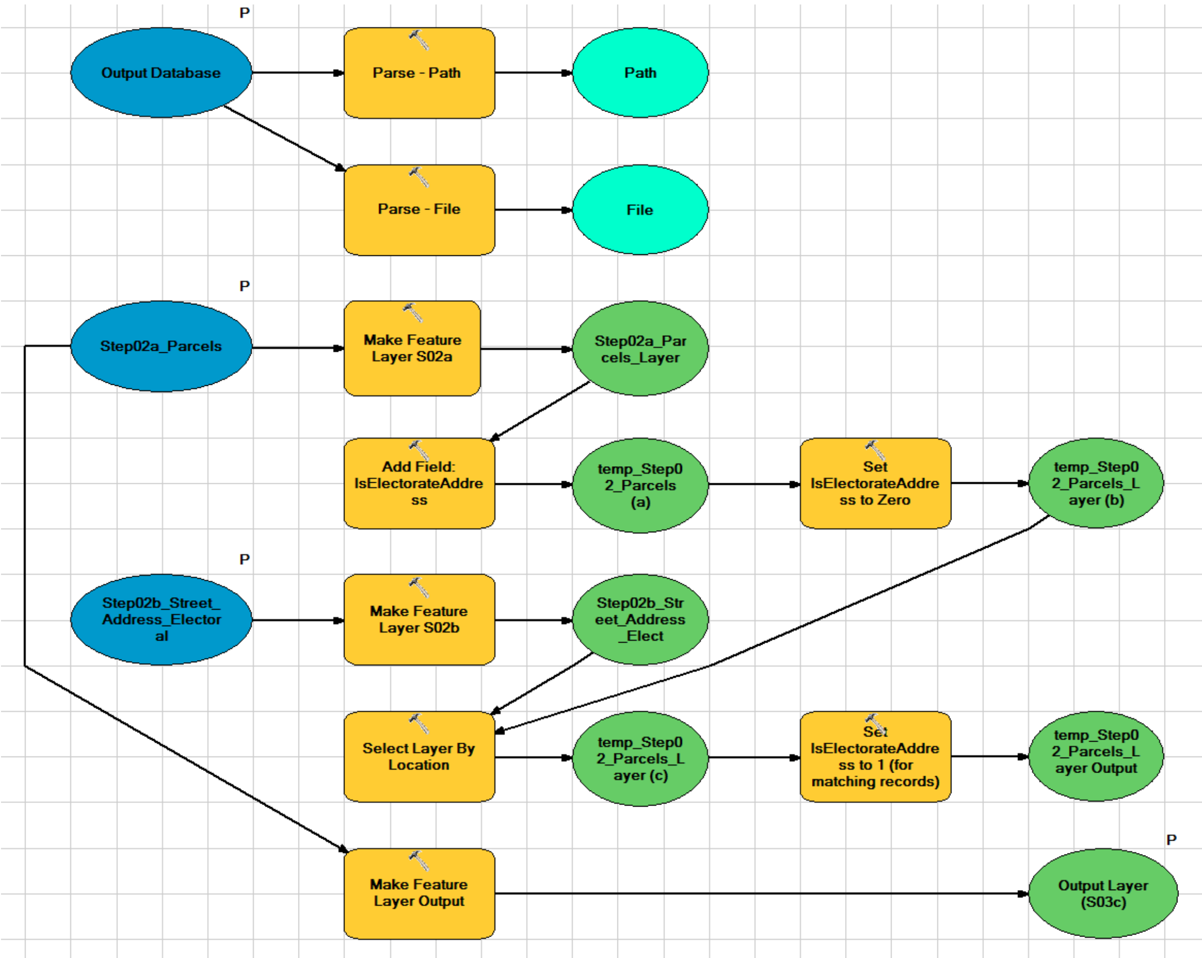
Step03b IsTransport




```
# ---------------------------------------------------------------------------
# S03b.py
# Created on: 2014-12-05 10:52:08.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S03b <Output_Database> <Output_Layer__S03b_> <Steo02a_Parcels>
# Description:
# Creates a Binary Mask for Transport networks (rail and road) based on the Parcel Itent data.
# We explored using additional Topographic data for this but there were many inconsistencies
# between the two datasets leading to artificial fragmentation.
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
```

```
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Development.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Development.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Development.gdb" # provide a default value if unspecified

Output_Layer__S03b_ = arcpy.GetParameterAsText(1)
if Output_Layer__S03b_ == '#' or not Output_Layer__S03b_:
    Output_Layer__S03b_ = "Output Layer (local S03b)" # provide a default value if unspecified

Steo02a_Parcels = arcpy.GetParameterAsText(2)
if Steo02a_Parcels == '#' or not Steo02a_Parcels:
    Steo02a_Parcels =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Development.gdb\\Step02a_Parcels" # provide a default value if unspecified

# Local variables:
temp_Step03_IsTransport__c_ = Output_Database
temp_Step03a_IsTransport__d_ = temp_Step03_IsTransport__c_
temp_Step03a_IsTransport__e_ = temp_Step03a_IsTransport__d_
Path = Output_Database
File = Output_Database
Step02a_Parcels_Layer = Steo02a_Parcels
temp_Step03_Parcels_Transport__b_ = Step02a_Parcels_Layer

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Steo02a_Parcels, Step02a_Parcels_Layer, "", "", "OBJECTID
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;id id VISIBLE NONE;appellation appellation
VISIBLE NONE;affected_surveys affected_surveys VISIBLE NONE;parcel_intent parcel_intent
VISIBLE NONE;topology_type topology_type VISIBLE NONE;status status VISIBLE
NONE;statutory_actions statutory_actions VISIBLE NONE;land_district land_district VISIBLE
NONE;titles titles VISIBLE NONE;survey_area survey_area VISIBLE NONE;calc_area calc_area
VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE
NONE;IsElectorateAddress IsElectorateAddress VISIBLE NONE")

# Process: Select Layer By Attribute
arcpy.SelectLayerByAttribute_management(Step02a_Parcels_Layer, "NEW_SELECTION", "parcel_intent
= 'Railway' OR parcel_intent = 'Road'")

# Process: Save IsTransport
arcpy.FeatureClassToFeatureClass_conversion(temp_Step03_Parcels_Transport__b_,
Output_Database, "Step03a_IsTransport", "", "", "")

# Process: Add Field
arcpy.AddField_management(temp_Step03_IsTransport__c_, "IsTransport", "SHORT", "", "", "", "",
"NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field
arcpy.CalculateField_management(temp_Step03a_IsTransport__d_, "IsTransport", "1", "VB", "")

# Process: Feature Layer Output
arcpy.MakeFeatureLayer_management(temp_Step03a_IsTransport__e_, Output_Layer__S03b_, "", "",
"OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;IsTransport IsTransport VISIBLE
NONE")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")
```

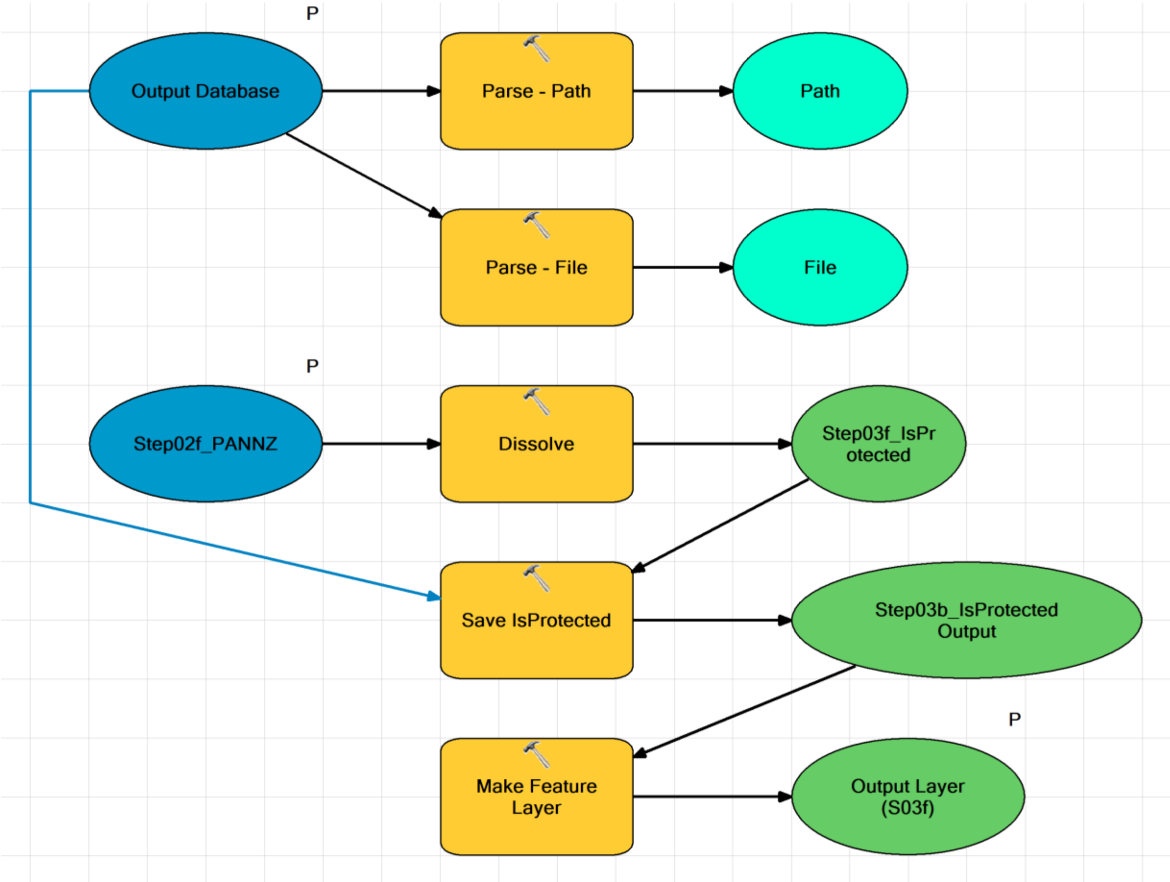
Step03c IsElectorateAddress




```
# ---------------------------------------------------------------------------
# S03c.py
# Created on: 2014-12-05 10:52:22.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S03c <Output_Database> <Output_Layer__S03c_> <Step02a_Parcels>
#    <Step02b_Street_Address_Electoral>
# Description:
# Adds a field (IsElectoralAddress) to the imported Parcels data set.
# For each polygon that contains an Electoral Address point flags the value to 1
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace = "%Path%\\%File%"
arcpy.env.workspace = "%Path%\\%File%"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Output_Layer__S03c_ = arcpy.GetParameterAsText(1)
if Output_Layer__S03c_ == '#' or not Output_Layer__S03c_:
    Output_Layer__S03c_ = "Output Layer (Local S03c)" # provide a default value if unspecified

Step02a_Parcels = arcpy.GetParameterAsText(2)
```

```
if Step02a_Parcels == '#' or not Step02a_Parcels:
    Step02a_Parcels = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02a_Parcels" # provide a default value if unspecified

Step02b_Street_Address_Electoral = arcpy.GetParameterAsText(3)
if Step02b_Street_Address_Electoral == '#' or not Step02b_Street_Address_Electoral:
    Step02b_Street_Address_Electoral = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02b_Street_Address_Electoral" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Step02a_Parcels_Layer = Step02a_Parcels
temp_Step02_Parcels__a_ = Step02a_Parcels_Layer
temp_Step02_Parcels_Layer__b_ = temp_Step02_Parcels__a_
temp_Step02_Parcels_Layer__c_ = temp_Step02_Parcels_Layer__b_
temp_Step02_Parcels_Layer_Output__d_ = temp_Step02_Parcels_Layer__c_
Step02b_Street_Address_Elect = Step02b_Street_Address_Electoral

# Process: Make Feature Layer S02a
arcpy.MakeFeatureLayer_management(Step02a_Parcels, Step02a_Parcels_Layer, "", "", "OBJECTID
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;id id VISIBLE NONE;appellation appellation
VISIBLE NONE;affected_surveys affected_surveys VISIBLE NONE;parcel_intent parcel_intent
VISIBLE NONE;topology_type topology_type VISIBLE NONE;status status VISIBLE
NONE;statutory_actions statutory_actions VISIBLE NONE;land_district land_district VISIBLE
NONE;titles titles VISIBLE NONE;survey_area survey_area VISIBLE NONE;calc_area calc_area
VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE
NONE;IsElectorateAddress IsElectorateAddress VISIBLE NONE")

# Process: Add Field: IsElectorateAddress
arcpy.AddField_management(Step02a_Parcels_Layer, "IsElectorateAddress", "SHORT", "", "", "",
"", "NULLABLE", "NON_REQUIRED", "")

# Process: Set IsElectorateAddress to Zero
arcpy.CalculateField_management(temp_Step02_Parcels__a_, "IsElectorateAddress", "0", "VB", "")

# Process: Make Feature Layer S02b
arcpy.MakeFeatureLayer_management(Step02b_Street_Address_Electoral,
Step02b_Street_Address_Elect, "", "", "OBJECTID OBJECTID VISIBLE NONE;SHAPE SHAPE VISIBLE
NONE;id id VISIBLE NONE;rna_id rna_id VISIBLE NONE;rcl_id rcl_id VISIBLE NONE;address address
VISIBLE NONE;house_number house_number VISIBLE NONE;range_low range_low VISIBLE
NONE;range_high range_high VISIBLE NONE;road_name road_name VISIBLE NONE;locality locality
VISIBLE NONE;territorial_authority territorial_authority VISIBLE NONE")

# Process: Select Layer By Location
arcpy.SelectLayerByLocation_management(temp_Step02_Parcels_Layer__b_, "CONTAINS",
Step02b_Street_Address_Elect, "", "NEW_SELECTION")

# Process: Set IsElectorateAddress to 1 (for matching records)
arcpy.CalculateField_management(temp_Step02_Parcels_Layer__c_, "IsElectorateAddress", "1",
"VB", "")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Make Feature Layer Output
arcpy.MakeFeatureLayer_management(Step02a_Parcels, Output_Layer__S03c_, "", "", "OBJECTID
OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;id id VISIBLE NONE;appellation appellation
VISIBLE NONE;affected_surveys affected_surveys VISIBLE NONE;parcel_intent parcel_intent
VISIBLE NONE;topology_type topology_type VISIBLE NONE;status status VISIBLE
NONE;statutory_actions statutory_actions VISIBLE NONE;land_district land_district VISIBLE
NONE;titles titles VISIBLE NONE;survey_area survey_area VISIBLE NONE;calc_area calc_area
VISIBLE NONE;Shape_Length Shape_Length VISIBLE NONE;Shape_Area Shape_Area VISIBLE
NONE;IsElectorateAddress IsElectorateAddress VISIBLE NONE")
```

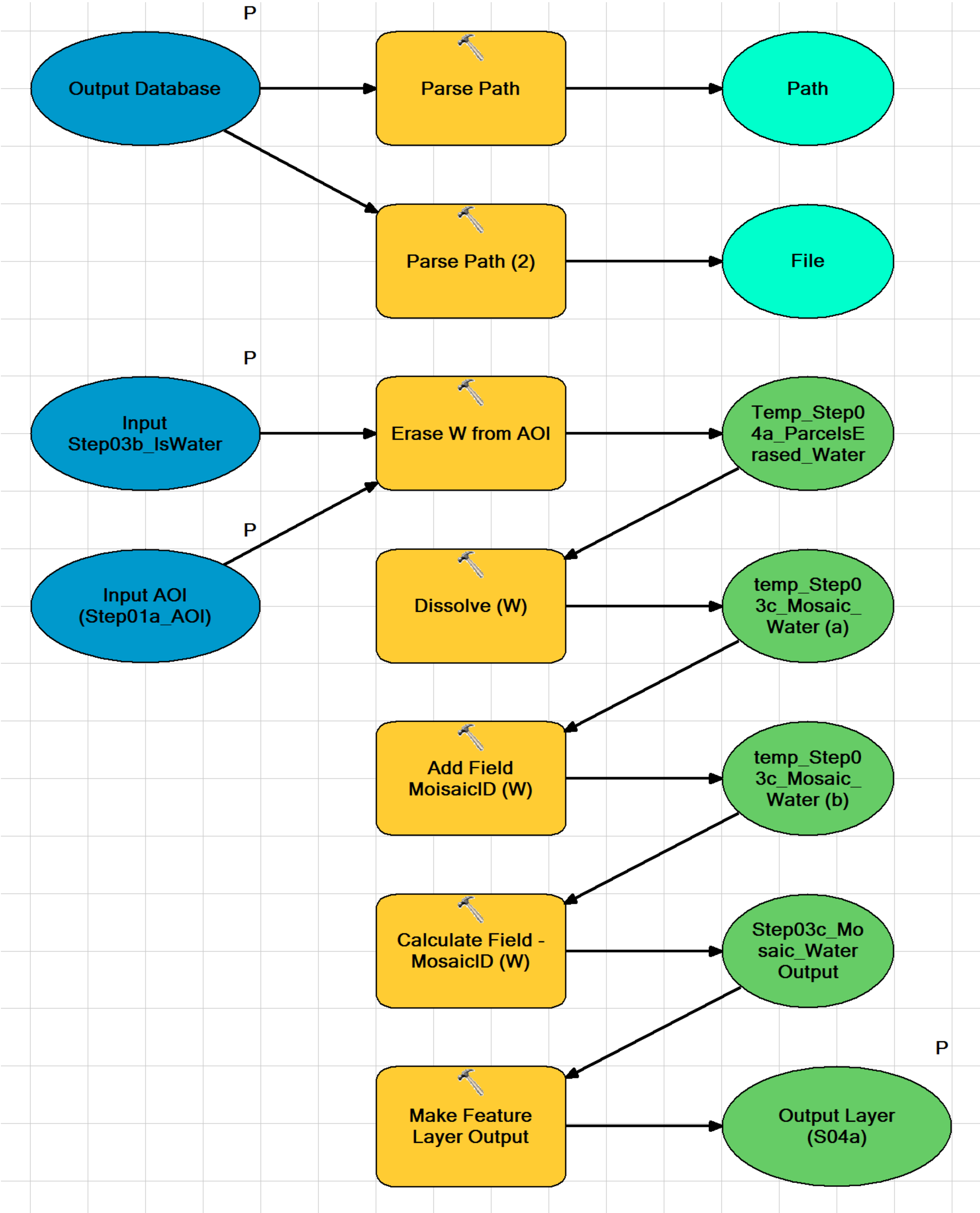
Step03f IsProtected




```
# ---------------------------------------------------------------------------
# S03f.py
# Created on: 2014-12-05 10:52:36.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S03f <Output_Database> <Step02f_PANNZ> <Output_Layer__S03f_>
# Description:
# Creates an IsProtected binary Mask from the PAN-NZ dataset
# using the field (IsProtected) that was added during the import step.
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Step02f_PANNZ = arcpy.GetParameterAsText(1)
if Step02f_PANNZ == '#' or not Step02f_PANNZ:
    Step02f_PANNZ = "%Path%\\%File%\\Step02f_PANNZ" # provide a default value if unspecified

Output_Layer__S03f_ = arcpy.GetParameterAsText(2)
```

```
if Output_Layer__S03f_ == '#' or not Output_Layer__S03f_:
    Output_Layer__S03f_ = "Output Layer (Local S03f)" # provide a default value if unspecified

# Local variables:
Step03b_IsProtected_Output = Output_Database
Path = Output_Database
File = Output_Database
Step03f_IsProtected = Step02f_PANNZ

# Process: Dissolve
arcpy.Dissolve_management(Step02f_PANNZ, Step03f_IsProtected, "IsProtected", "",
"SINGLE_PART", "DISSOLVE_LINES")

# Process: Save IsProtected
arcpy.FeatureClassToFeatureClass_conversion(Step03f_IsProtected, Output_Database,
"Step03b_IsProtected", "", "IsProtected \"IsProtected\" true true false 2 Short 0 0
,First,#,%Output Database%\\Step03f_IsProtected,IsProtected,-1,-1", "")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(Step03b_IsProtected_Output, Output_Layer__S03f_, "", "",
"IsProtected IsProtected VISIBLE NONE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")
```

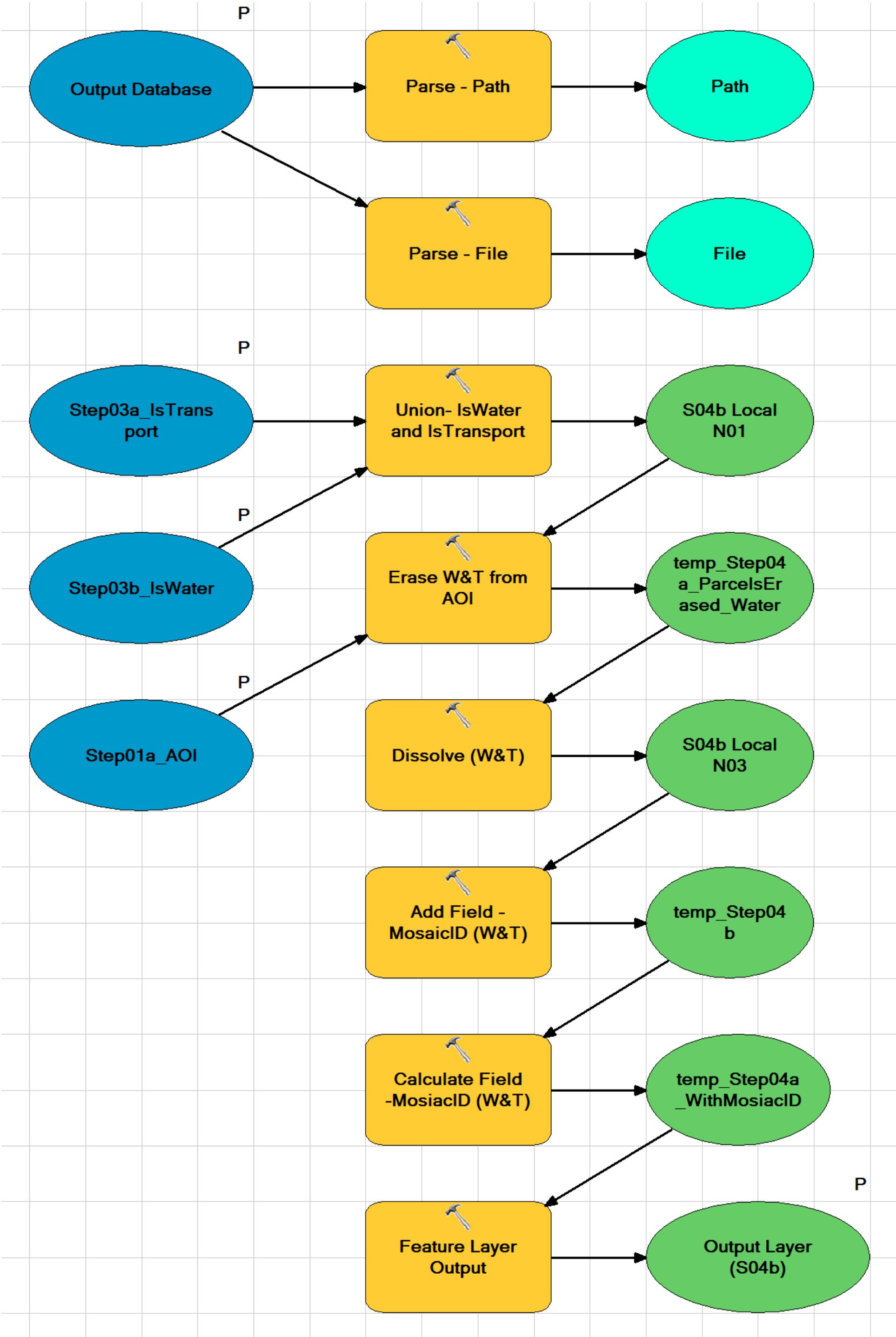
Step04a Mosaic Water (Run)




```
# ---------------------------------------------------------------------------
# S04a.py
# Created on: 2014-12-05 10:52:52.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S04a <Output_Database> <Input_AOI__Step01a_AOI_>
#    <Input_Step03b_IsWater> <Output_Layer__S04a_>
# Description:
# Creates a layer that divides the region (AOI) into discrete areas
# divided by the IsWater mask.  Each resulting area is given a unique ID.
# ---------------------------------------------------------------------------

# Set the necessary product code
# import arcinfo

# Import arcpy module
```

```
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace = "%Path%\\%File%"
arcpy.env.workspace = "%Path%\\%File%"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input_AOI__Step01a_AOI_ = arcpy.GetParameterAsText(1)
if Input_AOI__Step01a_AOI_ == '#' or not Input_AOI__Step01a_AOI_:
    Input_AOI__Step01a_AOI_ = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

Input_Step03b_IsWater = arcpy.GetParameterAsText(2)
if Input_Step03b_IsWater == '#' or not Input_Step03b_IsWater:
    Input_Step03b_IsWater = 
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step03b_IsWater" # provide a default value if unspecified

Output_Layer__S04a_ = arcpy.GetParameterAsText(3)
if Output_Layer__S04a_ == '#' or not Output_Layer__S04a_:
    Output_Layer__S04a_ = "Output Layer(Local S04a)" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Temp_Step04a_ParcelsErased_Water = Input_AOI__Step01a_AOI_
temp_Step03c_Mosaic_Water__a_ = Temp_Step04a_ParcelsErased_Water
temp_Step03c_Mosaic_Water__b_ = temp_Step03c_Mosaic_Water__a_
Step03c_Mosaic_Water_Output = temp_Step03c_Mosaic_Water__b_

# Process: Parse Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse Path (2)
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Erase W from AOI
arcpy.Erase_analysis(Input_AOI__Step01a_AOI_, Input_Step03b_IsWater, 
Temp_Step04a_ParcelsErased_Water, "")

# Process: Dissolve (W)
arcpy.Dissolve_management(Temp_Step04a_ParcelsErased_Water, temp_Step03c_Mosaic_Water__a_, "", 
"", "SINGLE_PART", "DISSOLVE_LINES")

# Process: Add Field MoisaicID (W)
arcpy.AddField_management(temp_Step03c_Mosaic_Water__a_, "MosaicID_Water", "LONG", "", "", "", 
"", "NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field - MosaicID (W)
arcpy.CalculateField_management(temp_Step03c_Mosaic_Water__b_, "MosaicID_Water", "[OBJECTID]", 
"VB", "")

# Process: Make Feature Layer Output
arcpy.MakeFeatureLayer_management(Step03c_Mosaic_Water_Output, Output_Layer__S04a_, "", "", 
"OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;MosaicID_Water MosaicID_Water VISIBLE 
NONE")
```

Step04b Mosaic Water or Transport

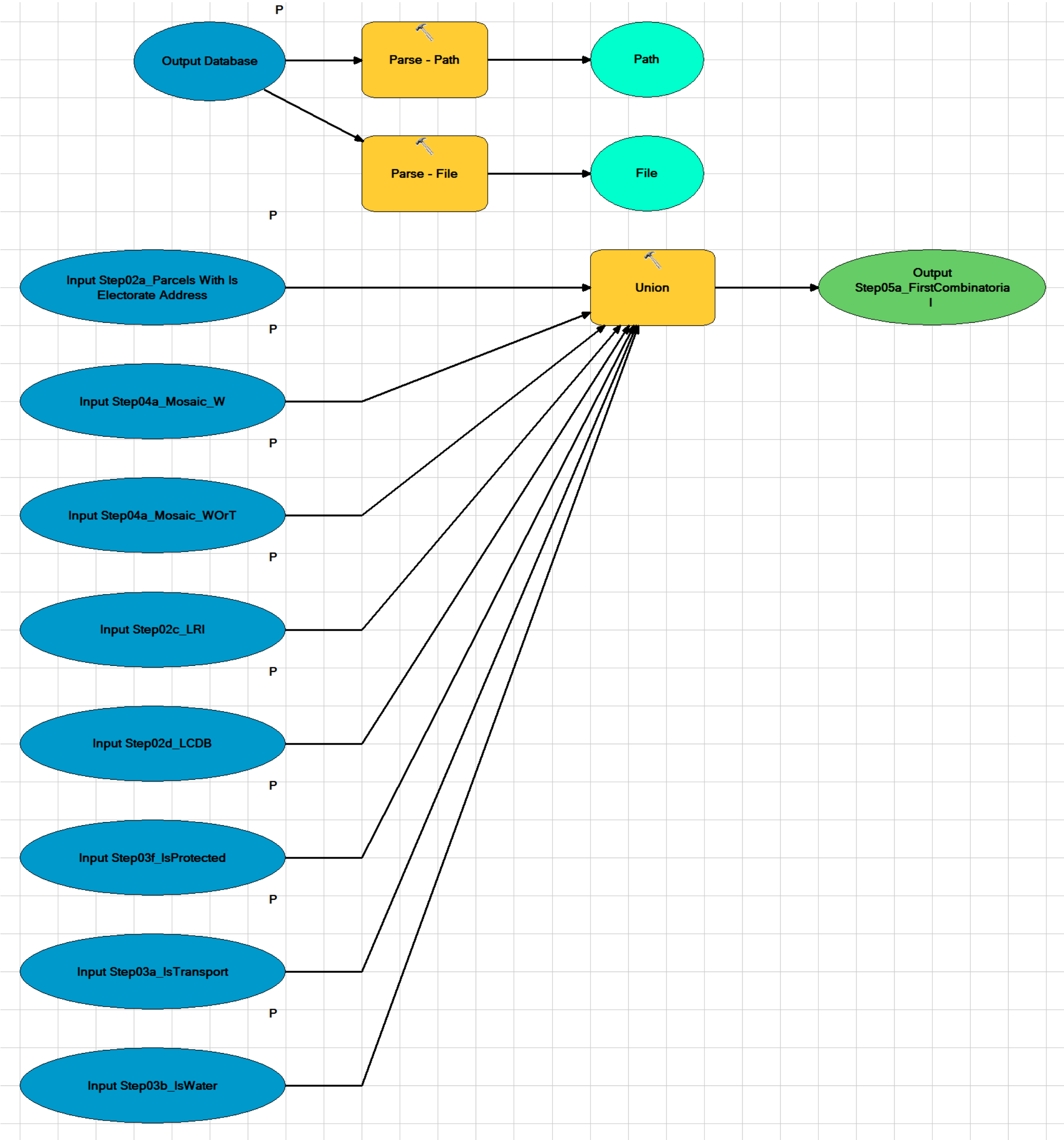



```
# ---------------------------------------------------------------------------
# S04b.py
# Created on: 2014-12-05 10:53:03.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S04b <Output_Database> <Step03a_IsTransport> <Step03b_IsWater> <Step01a_AOI>
<Output_Layer__S04b_>
# Description:
# Creates a Mosiac layer for the landscape (AOI) divided by Both Water and transport networks.
# The ISWater and IsWater layers are Unioned and Dissolved.
# This is subtracted from the AOI each resultant polygon is given a unique number.
# This creates a layer where each discrete "Tile" has a unique number,
# and the "grout" (Water and transport) become negative space.
```

```
# ---------------------------------------------------------------------------

# Set the necessary product code
# import arcinfo


# Import arcpy module
import arcpy

# Load required toolboxes
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Step03a_IsTransport = arcpy.GetParameterAsText(1)
if Step03a_IsTransport == '#' or not Step03a_IsTransport:
    Step03a_IsTransport =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step03a_IsTransport" # provide a default value if unspecified

Step03b_IsWater = arcpy.GetParameterAsText(2)
if Step03b_IsWater == '#' or not Step03b_IsWater:
    Step03b_IsWater =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step03b_IsWater" # provide a default value if unspecified

Step01a_AOI = arcpy.GetParameterAsText(3)
if Step01a_AOI == '#' or not Step01a_AOI:
    Step01a_AOI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step01a_AOI" # provide a default value if unspecified

Output_Layer__S04b_ = arcpy.GetParameterAsText(4)
if Output_Layer__S04b_ == '#' or not Output_Layer__S04b_:
    Output_Layer__S04b_ = "Output Layer S04b" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
S04b_Local_N01 = Step03a_IsTransport
temp_Step04a_ParcelsErased_WaterOrTransport = S04b_Local_N01
S04b_Local_N03 = temp_Step04a_ParcelsErased_WaterOrTransport
temp_Step04b = S04b_Local_N03
temp_Step04a_WithMosiacID = temp_Step04b

# Process: Union- IsWater and IsTransport
arcpy.Union_analysis("P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Gu
idelines_V03_Development.gdb\\Step03a_IsTransport
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step03b_IsWater #", S04b_Local_N01, "ALL", "", "GAPS")

# Process: Erase W&T from AOI
arcpy.Erase_analysis(Step01a_AOI, S04b_Local_N01, temp_Step04a_ParcelsErased_WaterOrTransport,
"")

# Process: Dissolve (W&T)
arcpy.Dissolve_management(temp_Step04a_ParcelsErased_WaterOrTransport, S04b_Local_N03, "", "",
"SINGLE_PART", "DISSOLVE_LINES")

# Process: Add Field - MosaicID (W&T)
arcpy.AddField_management(S04b_Local_N03, "MosaicID_WaterTransport", "LONG", "", "", "", "",
"NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field -MosiacID (W&T)
```

```
arcpy.CalculateField_management(temp_Step04b, "MosaicID_WaterTransport", "[OBJECTID]", "VB",
"")

# Process: Feature Layer Output
arcpy.MakeFeatureLayer_management(temp_Step04a_WithMosiacID, Output_Layer__S04b_, "", "",
"OBJECTID OBJECTID VISIBLE NONE;Shape Shape VISIBLE NONE;MosaicID_WaterTransport
MosaicID_WaterTransport VISIBLE NONE")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")
```

Step05a Parcels First Combinatorial

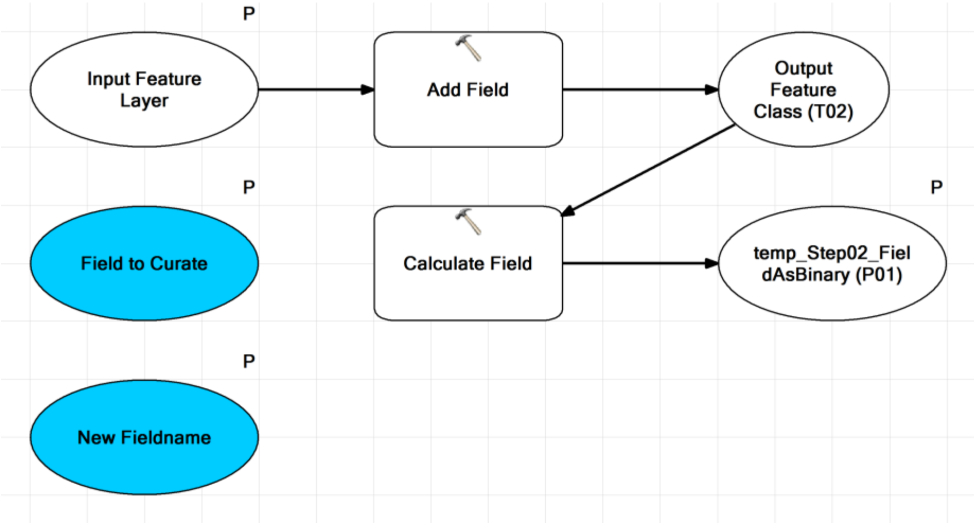



```
# ---------------------------------------------------------------------------
# S05a.py
# Created on: 2014-12-05 10:53:17.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: S05a <Output_Database> <Input_Step02a_Parcels_With_Is_Electorate_Address>
#    <Input_Step04a_Mosaic_W> <Input_Step04a_Mosaic_WOrT> <Input_Step02c_LRI>
#    <Input_Step02d_LCDB> <Input_Step03f_IsProtected>
#    <Input_Step03a_IsTransport> <Input_Step03b_IsWater>
# Description:
# Runs a Union on the eight key layers:
# Parcels, LUC, LCDB, Water Mosaid, Water or transport Mosaic, Proteced Areas,
# (plus Water and Transport though they are techncally redudant and may be ommited)
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Load required toolboxes
```

```
arcpy.ImportToolbox("Model Functions")

# Set Geoprocessing environments
arcpy.env.scratchWorkspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"
arcpy.env.workspace =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb"

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)
if Output_Database == '#' or not Output_Database:
    Output_Database =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb" # provide a default value if unspecified

Input_Step02a_Parcels_With_Is_Electorate_Address = arcpy.GetParameterAsText(1)
if Input_Step02a_Parcels_With_Is_Electorate_Address == '#' or not
Input_Step02a_Parcels_With_Is_Electorate_Address:
    Input_Step02a_Parcels_With_Is_Electorate_Address =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02a_Parcels" # provide a default value if unspecified

Input_Step04a_Mosaic_W = arcpy.GetParameterAsText(2)
if Input_Step04a_Mosaic_W == '#' or not Input_Step04a_Mosaic_W:
    Input_Step04a_Mosaic_W =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step04a_Mosaic_Water" # provide a default value if unspecified

Input_Step04a_Mosaic_WOrT = arcpy.GetParameterAsText(3)
if Input_Step04a_Mosaic_WOrT == '#' or not Input_Step04a_Mosaic_WOrT:
    Input_Step04a_Mosaic_WOrT =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step04a_Mosaic_WaterOrTransport" # provide a default value if unspecified

Input_Step02c_LRI = arcpy.GetParameterAsText(4)
if Input_Step02c_LRI == '#' or not Input_Step02c_LRI:
    Input_Step02c_LRI =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02c_LRI" # provide a default value if unspecified

Input_Step02d_LCDB = arcpy.GetParameterAsText(5)
if Input_Step02d_LCDB == '#' or not Input_Step02d_LCDB:
    Input_Step02d_LCDB =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step02d_LCDB" # provide a default value if unspecified

Input_Step03f_IsProtected = arcpy.GetParameterAsText(6)
if Input_Step03f_IsProtected == '#' or not Input_Step03f_IsProtected:
    Input_Step03f_IsProtected =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step03b_IsProtected" # provide a default value if unspecified

Input_Step03a_IsTransport = arcpy.GetParameterAsText(7)
if Input_Step03a_IsTransport == '#' or not Input_Step03a_IsTransport:
    Input_Step03a_IsTransport =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step03a_IsTransport" # provide a default value if unspecified

Input_Step03b_IsWater = arcpy.GetParameterAsText(8)
if Input_Step03b_IsWater == '#' or not Input_Step03b_IsWater:
    Input_Step03b_IsWater =
"P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Developm
ent.gdb\\Step03b_IsWater" # provide a default value if unspecified

# Local variables:
Path = Output_Database
File = Output_Database
Output_Step05a_FirstCombinatorial_ = Input_Step02a_Parcels_With_Is_Electorate_Address

# Process: Union
arcpy.Union_analysis("P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Gu
idelines_V03_Development.gdb\\Step02a_Parcels
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step04a_Mosaic_Water
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
```

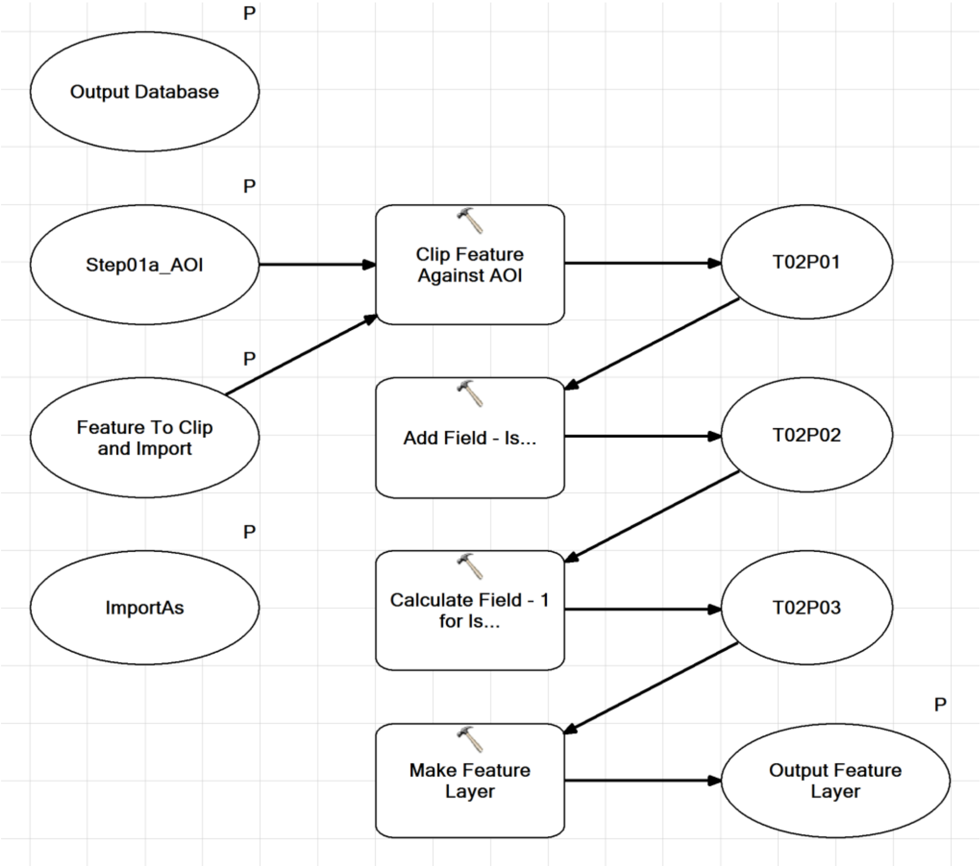
```
ment.gdb\\Step04a_Mosaic_WaterOrTransport
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step02c_LRI
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step02d_LCDB
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step03b_IsProtected
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step03a_IsTransport
#;P:\\Projects\\SL1312_LandFragmentation\\Data\\Databases\\ESRI\\SL1312_Guidelines_V03_Develop
ment.gdb\\Step03b_IsWater #", Output_Step05a_FirstCombinatorial_, "ALL", "", "GAPS")

# Process: Parse - Path
arcpy.ParsePath_mb(Output_Database, "PATH")

# Process: Parse - File
arcpy.ParsePath_mb(Output_Database, "FILE")
```

Tool01 Field As Binary




```
# ---------------------------------------------------------------------------
# T01_FieldAsBinary.py
# Created on: 2014-12-04 15:03:21.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: T01_FieldAsBinary <New_Fieldname> <Field_to_Curate>
#    <Input_Feature_Layer> <temp_Step02_FieldAsBinary__P01_>
# Description:
# Calculates the value of a field as 1/0 based on values.
# Renames the field to the value specified by "New Fieldname".
#
# All values > -1 are set to 1, anything less than 0 is set to 0
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Script arguments
New_Fieldname = arcpy.GetParameterAsText(0)
if New_Fieldname == '#' or not New_Fieldname:
    New_Fieldname = "Airport" # provide a default value if unspecified

Field_to_Curate = arcpy.GetParameterAsText(1)
if Field_to_Curate == '#' or not Field_to_Curate:
    Field_to_Curate = "FID_Temp_Step02e_Topo_Airport" # provide a default value if unspecified

Input_Feature_Layer = arcpy.GetParameterAsText(2)

temp_Step02_FieldAsBinary__P01_ = arcpy.GetParameterAsText(3)

# Local variables:
Output_Feature_Class__T02_ = Input_Feature_Layer

# Process: Add Field
arcpy.AddField_management(Input_Feature_Layer, "%New Fieldname%", "SHORT", "", "", "", "%New
Fieldname%", "NULLABLE", "NON_REQUIRED", "")

# Process: Calculate Field
arcpy.CalculateField_management(Output_Feature_Class__T02_, "%New Fieldname%",
"AsBinary(!%Field To Curate%!)", "PYTHON_9.3", "def AsBinary(valCurrent):\\n    if (
valCurrent > -1):\\n        return 1\\n    else:\\n        return 0")
```

Tool02 Import And Clip Layer As Atom




```
# ---------------------------------------------------------------------------
# T02_ImportAsBinary.py
# Created on: 2014-12-04 14:51:42.00000
#   (generated by ArcGIS/ModelBuilder)
# Usage: T02_ImportAsBinary <Output_Database> <Output_Feature_Layer>
#    <ImportAs> <Step01a_AOI> <Feature_To_Clip_and_Import>
# Description:
# Take specified Layer and Imports using a Clip against the AOI Step01a_AOI
# ---------------------------------------------------------------------------

# Import arcpy module
import arcpy

# Set Geoprocessing environments
arcpy.env.scratchWorkspace = ""
arcpy.env.workspace = ""

# Script arguments
Output_Database = arcpy.GetParameterAsText(0)

Output_Feature_Layer = arcpy.GetParameterAsText(1)
if Output_Feature_Layer == '#' or not Output_Feature_Layer:
    Output_Feature_Layer = "Output Layer (T02)" # provide a default value if unspecified

ImportAs = arcpy.GetParameterAsText(2)

Step01a_AOI = arcpy.GetParameterAsText(3)

Feature_To_Clip_and_Import = arcpy.GetParameterAsText(4)

# Local variables:
T02P01 = Step01a_AOI
T02P02 = T02P01
T02P03 = T02P02

# Process: Clip Feature Against AOI
```

```
arcpy.Clip_analysis(Feature_To_Clip_and_Import, Step01a_AOI, T02P01, "")

# Process: Add Field - Is...
arcpy.AddField_management(T02P01, "IsPoly", "SHORT", "", "", "", "", "NULLABLE",
"NON_REQUIRED", "")

# Process: Calculate Field - 1 for Is...
arcpy.CalculateField_management(T02P02, "IsPoly", "1", "VB", "")

# Process: Make Feature Layer
arcpy.MakeFeatureLayer_management(T02P03, Output_Feature_Layer, "", "", "IsPoly IsPoly VISIBLE
NONE")
```