SCIRT Rebuilding Infrastructure

LEARNING LEGACY

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Multi Criteria Analysis Asset Prioritisation Tool

Story: Project Prioritisation

Theme: Programme Management

A document which outlines the processes involved in the Multi Criteria Analysis Asset Prioritisation tool. It also talks about assumptions made and potential gaps.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz

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Multi Criteria Analysis Asset Prioritisation Tool

Revision: 1.0

Date: 30/11/2012

Contents

Revision History

Revision	Date	Name	Brief Description of Change
1.0	31/05/2012	Keith Hastings	Version 1

1. Introduction

This document outlines the general processes involved in the Multi Criteria Analysis Asset Prioritisation tool.

It also talks about assumptions made, potential gaps, and is dynamic in the sense that there will be new sections added to incorporate updates to the tool as new data, or revisions based on validation come to hand.

2. Software

The tool has been developed completely within the Feature Manipulation Engine (FME) software provided by Safe Software.

This software provides a flow model environment where spatial and database functions and processes can be chained together to form a continuous chain process. This process can be constrained or modified by using user specified parameters at the start of any process 'run'.

3. Model Philosophy

The SCIRT GIS team maintains a large set of Spatial (and some non-spatial) databases as part of its core business. In most cases these databases are updated on a weekly basis, and form the basis of the web mapping layers as they are always the most current data that SCIRT has.

These databases form all the inputs to the MCA tool. Every time the tool is run it always reads the data from these databases, so is always based on the latest information SCIRT has access to.

In general terms, the tool then takes all of this input data, and manipulates it by joining, analysing and applying factors to it to create the final MCA priority database.

The final prioritisation score is based on 4 factors: condition, criticality, level of service and maintenance costs. These individual factors are collected for each individual asset, stored, and then added together at the end of the process to produce a total prioritisation score. These total scores are then sorted and ranked.

The model has been designed so that the user can select to use either a Linear or Fibonacci sequence for the scoring range.

The user can also apply different weightings to each of the separate factors.

By default all weightings are set to 100%, and the scoring range uses the Fibonacci sequence.

3.1. Initial Scope of Model

The model was built initially to analyse only 3 of the asset types, Roads, Wastewater & Water Supply. It was decided that, at least in the initial versions of the tool, Stormwater would not be included, as it had very little collected data that could be used to assess priority, and was also deemed to not be a large driver of future project prioritisation.

The Model is flexible enough so that Stormwater can be added at any time.

At the time of the initial build of the model, and the initial results for the catchment priority blueprints released in February 2012, data for level of service and maintenance costs was not available. The model therefore only uses condition and criticality to assess priority for this initial blueprint release.

4. Model Details

For an explanation of the detailed mappings between the factors and their resultant scores please refer to Appendix A MCA Weighting Matrix.

Below is a very brief explanation of how each of the individual factors are calculated.

4.1. Wastewater

4.1.1. Condition

Condition data for Wastewater is partly sourced from Infonet data feeds, updated weekly. Only some assets have Infonet assessed information, i.e. those that have been through the CCTV review process. The remaining assets have a 'derived' condition that incorporates age, material and ground liquefaction. This derivation is calculated within the FME model.

A Design Life score is also calculated based on remaining asset life.

The final Condition score is taken as the greater of the Infonet and Design Life scores.

4.1.2. Criticality

Criticality data for Wastewater is sourced directly from the assets pipe diameter.

4.1.3. Level Of Service

Level of Service data for Wastewater is sourced from the assessed pipe fragility. This assessment was first created as a map by the condition assessment team.

4.1.4. Maintenance Costs

Maintenance Costs for Wastewater is sourced from a January 2012 BECA report that gives a maintenance cost for each asset type broken down to a catchment level. For the purposes of this model these costs have been applied to each asset within the catchment evenly.

4.2. Water Supply

4.2.1. Condition

Condition data for Water Supply is sourced from CityCare's CAMMS database. This is updated weekly and contains all repair jobs undertaken to date. In the model the individual repair jobs are assigned to the particular pipe assets and summarised to form an asset total repair count.

4.2.2. Criticality

Criticality data for Water Supply is sourced directly from the assets pipe diameter.

4.2.3. Level Of Service

Level of Service for Water Supply has been universally assigned as low.

4.2.4. Maintenance Costs

Maintenance Costs for Water Supply is sourced from a January 2012 BECA report that gives a maintenance cost for each asset type broken down to a catchment level. For the purposes of this model these costs have been applied to each asset within the catchment evenly.

4.3. Roads

4.3.1. Condition

Condition data for Roads is sourced from RAMMS. Christchurch City Council have recorded road damage throughout the city, and have interpolated a road damage score for each road section between 1 and 5. NZTA roads have been separately assessed to the same rating system by the Condition Assessment team.

4.3.2. Criticality

Criticality data for Roads is sourced from the daily vehicle traffic estimates recorded in RAMMS.

4.3.3. Level Of Service

Level of Service data for Roads is sourced from the rebuild priority of the Strategic Roads as identified by the Christchurch Strategic Roads group.

4.3.4. Maintenance Costs

Maintenance Costs for Wastewater is sourced from a January 2012 BECA report that gives a maintenance cost for each asset type broken down to a catchment level. For the purposes of this model these costs have been applied to each asset within the catchment evenly.

5. Tool Versions

5.1. Initial Build - 17/02/2012

Built for the 18 month Rebuild Programme released on 17/02/2012

This version only incorporates Condition and Criticality data, as other data was not available.

This model has been run assigning the Scores using the Fibonacci sequence.

No weightings have been applied between the different asset factors.

5.2. Version 2 - 29/05/2012

Built for the Second Release Rebuild Programme released on 29/05/2012

Both Level of Service and Maintenance Cost factors were incorporated into this version.

This model has been run assigning the Scores using the Fibonacci sequence.

No weightings have been applied between the different asset factors.

5.3. Version 3 - 30/11/2012

Built for the third release Rebuild Programme released on 30/11/2012.

This version includes updated data for both Level of Service and Maintenance Cost.

Level of Service for Wastewater now includes data about pipes that cross through red zone areas and infiltration rates on a sub catchment basis. This replaces the previous data from plans on WW fragility.

Level of Service for Roads now includes road complaints from the CSR database, State Highway condition and data derived from the marked up Operations plans. This replaces the previous data based on SH condition and Strategic Road priority.

Maintenance costs for both Wastewater and Water Supply have been updated to an improved sub catchment level. These costs are based on the 6 months from Sep 2011 – Feb 2012, and have been normalised to represent a cost per household unit for each sub catchment.

Maintenance costs for Roads have been updated, but are still based on a parent catchment level. These costs are based on the 6 months from Dec 2011 – May 2012, and have been normalised to represent a cost per household unit for each parent catchment.

6. Future Notes

There have been several areas identified where improvements may be made to the model. These are:

6.1. Derived Wastewater Condition

Currently those assets that have not undergone a CCTV review receive a derived condition score that uses a sensible, but fairly simplistic model.

The Wastewater Condition Assessment team have already developed a far more complex model for assessing derived condition for non-reviewed assets. An obvious next step for the asset prioritisation model is to incorporate either the data from this wastewater condition model or the model itself.

6.2. Improved Maintenance Cost Data

Initially the maintenance costs have been applied at a catchment level only. This means that all assets within the same catchment receive the same cost score. To give some perspective there are only 11 catchments in the Christchurch area.

Further refinement of this data will improve the accuracy of the results. It is likely that at some stage a sub catchment breakdown will become available to further refine the results. For the purposes of this model the ideal scenario is to have an asset specific breakdown of costs, however this seems very unlikely.

NOTE: This maintenance cost data has been improved to sub catchment level for Wastewater and Water Supply in Version 3.

6.3. Model Validation and Calibration using Weightings

Currently no detailed validation of the model has been carried out at an asset level. The only validation has been undertaken at a summarised catchment level, where model results have been compared to real world experience and build expectations of the catchments. This has so far proved to coincide quiet well, but a more detailed validation should be undertaken to assess how the real world situation compares to the model results at the individual asset level.

This validation will also lead to an informed discussion of applying weightings to the individual factors.

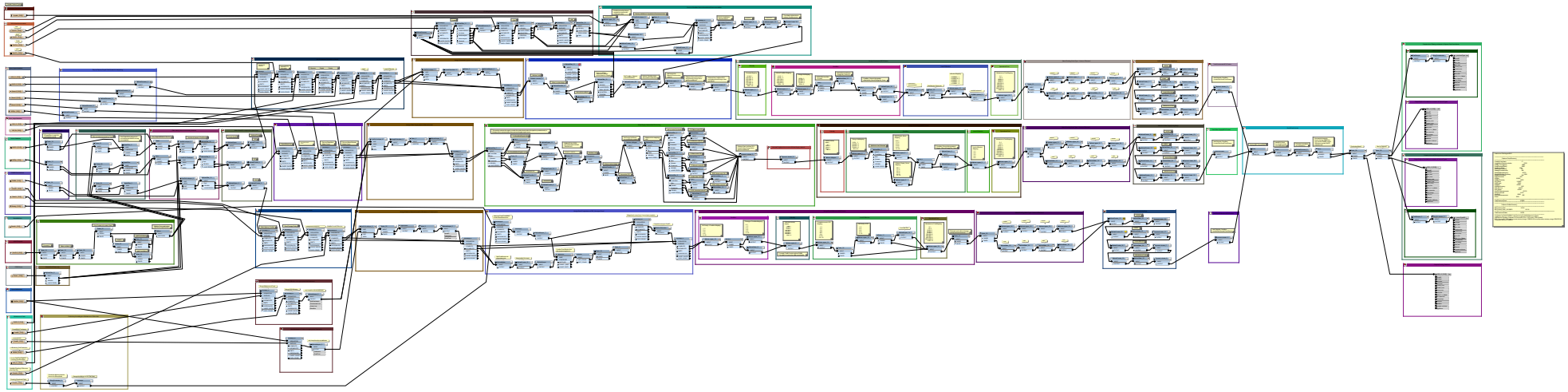
Currently all factors are weighted evenly.

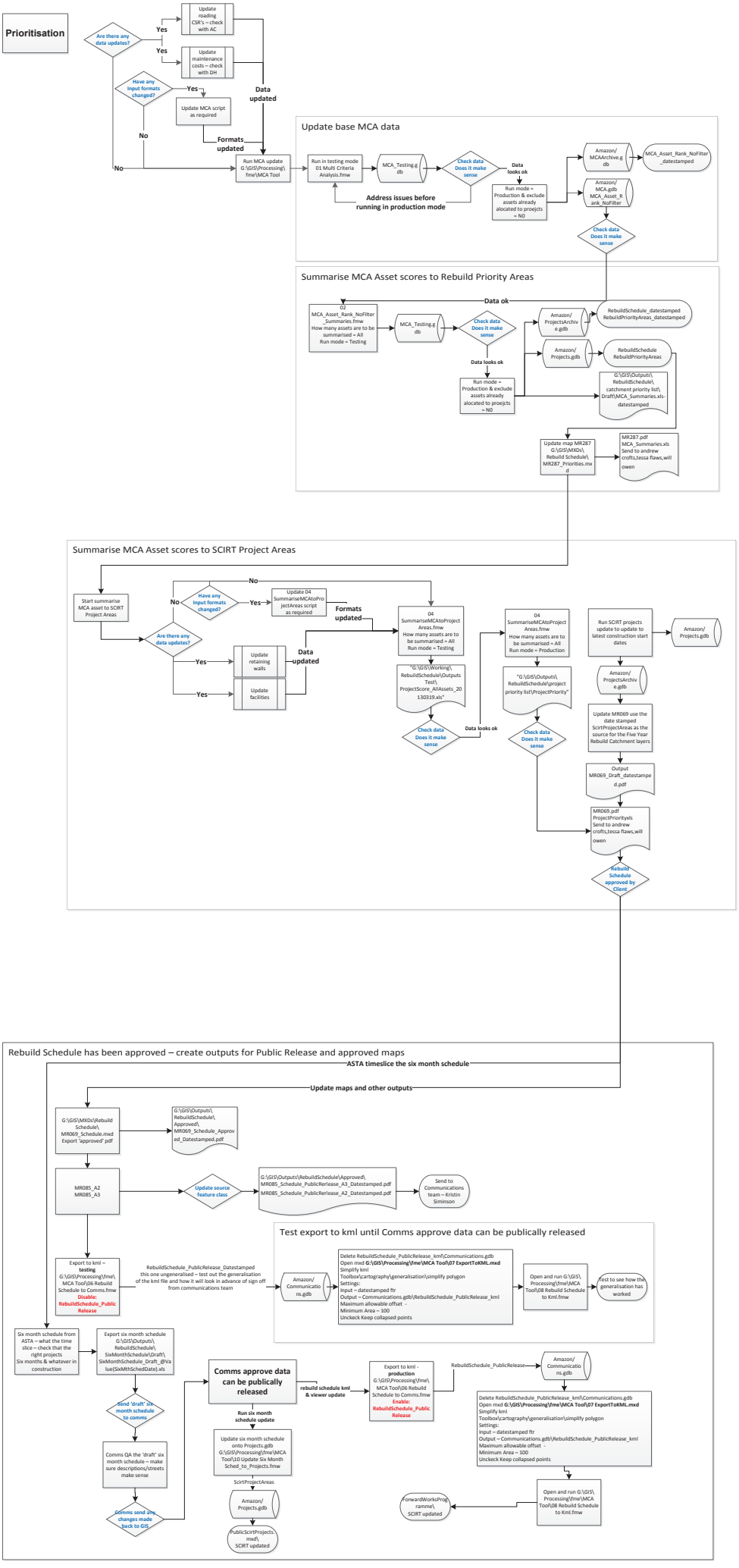
7. Appendix A – MCA Weighting Matrix

8. Appendix B – FME Model Diagram

MCA Asset Prioritisation Weighting Matrix

Linear Weighting	Fibonacci Weighting	Water Supply						Wastewater						Roads			
		Condition - largest of:			Criticality	Level Of Service (all treated as low)	Maintenance Costs	Condition - largest of:		Criticality	Level Of Service	Maintenance Costs		Condition	Criticality	Level Of Service	Maintenance Costs
		Street Section Repair Count		Design Life reached %	Pipe Diameter (mm)	Fragility	OPEX per catchment	Infonet Condition Score	Design Life reached %	Pipe Diameter (mm)	Fragility	OPEX per catchment		RAMM damage assessment	traffic count (vpd)	Strategic Roads Rebuild Priority	OPEX per catchment
		Mains	Submains														
1	1			< 10	< 100		0	0	< 10	< 150		0		0	< 250	0	0
2	2	1	1	< 50		1	1		< 50		High Infiltration HI	1		1		1	1
3	3			< 70	< 150		4	1	< 70			4					4
4	5	2	2		< 300		7	2		< 225	Badly Damaged (BD)	7		2	< 500	2	7
5	8			< 85	< 200		10		< 85		BD + HI	10			< 1000		10
6	13						14	3		< 300	High Failure (HF)	14		3	< 1500	3	14
7	21				< 300		18			< 375	HF + HI	18			< 2000		18
8	34	3	3				22	4		< 450	HF + BD	22		4	< 5000	4	22
9	55	4	4	>= 85	>= 300		26		>= 85	< 600	HF + BD + HI	26			< 10000		26
10	89	>= 5	>= 5				30	5		>= 600		30		5	>= 10000	5	30




Prioritisation
Are there any data updates?
Yes
Update roading CSR's – check with AC
Yes
Update maintenance costs – check with DH
Have any input formats changed?
Yes
Update MCA script as required
Data updated
No
Formats updated
No
Run MCA update G:\GIS\Processing\fme\MCA Tool
Update base MCA data
Run in testing mode 01 Multi Criteria Analysis.fmw
MCA_Testing.gdb
Check data Does it make sense
Data looks ok
Address issues before running in production mode
Run mode = Production & exclude assets already alocated to proejcts = N0
Amazon/MCAArchive.gdb
MCA_Asset_Rank_NoFilter_datestamped
Amazon/MCA.gdb MCA_Asset_Rank_NoFilter
Check data Does it make sense
Summarise MCA Asset scores to Rebuild Priority Areas
Data ok
02 MCA_Asset_Rank_NoFilter_Summaries.fmw How many assets are to be summarised = All Run mode = Testing
MCA_Testing.gdb
Check data Does it make sense
Amazon/ProjectsArchive.gdb
RebuildSchedule_datestamped RebuildPriorityAreas_datestamped
Data looks ok
Amazon/Projects.gdb
RebuildSchedule RebuildPriorityAreas
Run mode = Production & exclude assets already alocated to proejcts = N0
G:\GIS\Outputs\RebuildSchedule\catchment priority list\Draft\MCA_Summaries.xls-datestamped
Update map MR287 G:\GIS\MXDs\Rebuild Schedule\MR287_Priorities.mxd
MR287.pdf MCA_Summaries.xls Send to andrew crofts,tessa flaws,will owen
Summarise MCA Asset scores to SCIRT Project Areas
Start summarise MCA asset to SCIRT Project Areas
Are there any data updates?
Yes
Update retaining walls
Update facilities
Data updated
No
Have any input formats changed?
Yes
Update 04 SummariseMCAtoProjectAreas script as required
Formats updated
04 SummariseMCAtoProject Areas.fmw How many assets are to be summarised = All Run mode = Testing
"G:\GIS\Working\RebuildSchedule\Outputs Test\ProjectScore_AllAssets_20130319.xls"
Check data Does it make sense
Data looks ok
04 SummariseMCAtoProject Areas.fmw How many assets are to be summarised = All Run mode = Production
"G:\GIS\Outputs\RebuildSchedule\project priority list\ProjectPriority"
Check data Does it make sense
Run SCIRT projects update to update to latest construction start dates
Amazon/Projects.gdb
Amazon/ProjectsArchive.gdb
Update MR069 use the date stamped ScirtProjectAreas as the source for the Five Year Rebuild Catchment layers
Output MR069_Draft_datestamped.pdf
MR069.pdf ProjectPriorityxls Send to andrew crofts,tessa flaws,will owen
Rebuild Schedule approved by Client
Rebuild Schedule has been approved – create outputs for Public Release and approved maps
ASTA timeslice the six month schedule
Update maps and other outputs
G:\GIS\MXDs\RebuildSchedule\MR069_Schedule.mxd Export "approved" pdf
G:\GIS\Outputs\RebuildSchedule\Approved\MR069_Schedule_Approved_Datestamped.pdf
MR08S_A2 MR08S_A3
Update source feature class
G:\GIS\Outputs\RebuildSchedule\Approved\MR08S_Schedule_PublicRerlease_A3_Datestamped.pdf MR08S_Schedule_PublicRerlease_A2_Datestamped.pdf
Send to Communications team – Kristin Siminson
Test export to kml until Comms approve data can be publically released
Export to kml – testing G:\GIS\Processing\fme\MCA Tool\06 Rebuild Schedule to Comms.fmw Disable: RebuildSchedule_Public Release
RebuildSchedule_PublicRelease_Datestamped this one ungeneralised – test out the generalisation of the kml file and how it will look in advance of sign off from communications team
Amazon/Communications.gdb
Delete RebuildSchedule_PublicRelease_kml\Communications.gdb Open mxd G:\GIS\Processing\fme\MCA Tool\07 ExportToKML.mxd Simplify kml Toolbox\cartography\generalisation\simplify polygon Settings: Input – datestamped ftr Output – Communications.gdb\RebuildSchedule_PublicRelease_kml Maximum allowable offset - Minimum Area – 100 Uncheck Keep collapsed points
Open and run G:\GIS\Processing\fme\MCA Tool\08 Rebuild Schedule to Kml.fmw
Test to see how the generalisation has worked
Six month schedule from ASTA – what the time slice – check that the right projects Six months & whatever in construction
Export six month schedule G:\GIS\Outputs\RebuildSchedule\SixMonthSchedule\Draft\SixMonthSchedule_Draft_@Value(SixMthSchedDate).xls
Send 'draft' six month schedule to comms
Comms QA the 'draft' six month schedule – make sure descriptions/streets make sense
Comms send any changes made back to GIS
Comms approve data can be publically released
rebuild schedule kml & viewer update
Run six month schedule update
Update six month schedule onto Projects.gdb G:\GIS\Processing\fme\MCA Tool\10 Update Six Month Sched_to_Projects.fmw
ScirtProjectAreas
Amazon/Projects.gdb
PublicScirtProjects.mxd\ SCIRT updated
Export to kml – production G:\GIS\Processing\fme\MCA Tool\06 Rebuild Schedule to Comms.fmw Enable: RebuildSchedule_Public Release
RebuildSchedule_PublicRelease
Amazon/Communications.gdb
Delete RebuildSchedule_PublicRelease_kml\Communications.gdb Open mxd G:\GIS\Processing\fme\MCA Tool\07 ExportToKML.mxd Simplify kml Toolbox\cartography\generalisation\simplify polygon Settings: Input – datestamped ftr Output – Communications.gdb\RebuildSchedule_PublicRelease_kml Maximum allowable offset - Minimum Area – 100 Uncheck Keep collapsed points
Open and run G:\GIS\Processing\fme\MCA Tool\08 Rebuild Schedule to Kml.fmw
ForwardWorksProgramme\ SCIRT updated