UPlan Land Use Allocation Model 4.0

User's Manual

Developed by:
Ryan Boynton
Information Center for the Environment
Department of Environmental Science and Policy
University of California, Davis

Primary Contact at UC Davis: Ryan Boynton – rmboynton@ucdavis.edu

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Model Concept by Prof. Robert Johnson, David Shabazian, Shengyi Gao, Eric Lehmer, Mike McCoy, Nate Roth, Ryan Boynton and James Thorne

Coding by: Ryan Boynton, Nate Roth, and Jackie Bjorkman

Table of Contents

1 – Introduction

1.1 Overview

UPlan is a simple urban growth model. This tool is used to visualize and report likely future urban growth patterns. The user defines a series of map and population parameters and the model spatially allocates expected new population into new urban commercial and residential classes. These classes are distributed into the model area according to rules that the user defines. The program is run using Esri's ArcCatalog. To visualize the model outputs in ArcMap, the user opens the land parcel feature (layer) used in the modeling. The table join command is then used to attach output tables portraying the number of acres allocated by land use type in each parcel.

The goals for this model are to: (1) allow for the rapid development and implementation of a GIS based model projecting urban growth for relatively small regions such as counties, and (2) that inputs should be able to be locally derived, and be available to practitioners in most regions with modest data preparation.

These goals preclude some forms of complex tools and limit the model's ability to handle complex economic interactions. If addressing complex, interregional interactions are a priority, UPlan is not the appropriate tool, and we encourage you to look at PECAS, UrbanSim 2, MUSSA II, or other models more appropriate to handle those factors.

UPlan 4.0 is the fourth major update to the original UPlan model and is fully reprogrammed in Python and is programmed to run using ArcGIS 10.3 within ArcToolbox.

1.2 Concepts and Conversions

UPlan 4.0 was designed to operate with Esri's ArcGIS 10.3 application. Basic knowledge of ArcGIS 10.x, along with fundamental knowledge of land use is assumed throughout the UPlan User's Manual.

While a detailed understanding of planning and development is not necessary to operate UPlan 4, planning and zoning terminology is used throughout the User's Manual.

1.2.1 Target Users

UPlan 4.0 consists of 7 Python Toolboxes. It was designed as a tool to be used by a group of rural counties in California, but it is generalizable and can be applied to other areas for land use planning.

2 – UPlan Model

2.1 Background

Development of UPlan began in 2000 and has been funded and utilized by a variety of groups since then.

2.1.1 Version 1

Circa 2000-2003

Bob Johnston, David Shabazian, Shengyi Gao, Eric Lehmer, Chad Shook

Written in: ArcView Avenue

This version was used for several early applications of UPlan including work in and around Los Alamos following the fire and planning for reconstruction, the Merced Model Improvement Program, and the Delaware Valley.

2.1.2 Version 2.X

2003-2015

Bob Johnston, David Shabazian, Shengyi Gao, Eric Lehmer, Nathaniel Roth

Written in: VBA (ArcObjects)

Version 2.X received much wider use across more than twenty counties in the state of California as part of the San Joaquin Valley Partnership, San Joaquin Valley Blueprint, the Regional Blueprint projects (non-MPO RTPAs), several smaller specific projects within the state, across the US, and internationally. Additionally this version was extended to develop direct connections to several travel demand models (TransCAD, and EMME) and remains in use by several county level organizations in California.

2.1.3 Version 3

2012

Written in: VBA (ArcObjects)

This version had very little use. It remains fully operational, but was written just as ESRI announced the discontinuation of support for VBA and so little emphasis was placed on its use.

2.1.3 Version 4

2015-2016

Written in: Python (Arcpy)

Version 4 was written as an update to UPlan to preserve its functionality into a next generation of code for ArcGIS. It converts UPlan to a vector GIS model (instead of being raster based).

2.2 Design Objectives

The objective of developing UPlan was to create a simple rule based model that projects urban growth. Simple, so that the model could be inexpensive and available to a variety of interested parties. Rule based, so that the model is deterministic and its methodology is transparent to the user. The model doesn't need to be calibrated on historical data because its intended use is for long-range scenario testing. However, it relies on geographic data that represent existing urban, local general land use plans,

and other relevant natural and built features that define the model. The allocation rules must broadly simulate land markets. These objectives have guided the design and make it easy to use and informative for planners and citizen groups.

The UPlan model works based on the following assumptions:

- The population growth can be converted into demand for land use by applying conversion factors to employment and households.
- The new urban expansion will conform to city and county general plans.
- Locations have different attraction weights because of accessibility to transportation and infrastructure.
- Some areas, such as lakes and streams, will not be developed. Other areas, such as sensitive habitats and floodplains, will discourage new development

The UPlan model is designed to project the spatial allocation of residential and employment growth. The concepts it uses to project this growth are largely unchanged from the previous versions, although the methodology has been refined. The model spatially allocates the population and employment growth to the land use types that are designated in the general plan, while being responsive to maps that portray various attraction and discouragement weightings that rank all locations according their attraction for urban growth. The areas with higher attractiveness values will have more growth of residential and employment than those with lower attractiveness values, given the same amount of available land. Therefore, the cities with higher attractiveness and sufficient available land will have a higher share of population and employment growth.

2.3 Data Considerations

UPlan 4 is designed to run on vector (polygon) spatial datasets. Versions 1-3 were based on raster representations of the land, but due to technology advancements over the past 15 years, the limitations on disk space and model runtime are not as constrictive as they once were. By being vector based, the future growth can be assigned to any type of base geometry the user desires, such as parcel or planning unit boundaries, or a polygrid if they want the results to look similar to those of earlier versions. Using vector datasets also allows for more detailed distance calculations.

2.4 ArcGIS License Level

Some of the original methodology in UPlan4 utilized tools that aren't licensed at the ArcEditor level. To meet the needs of users that don't have the Full ArcInfo license (also referred to as the 'Advanced' level in the new version of Arc) we have included internal modifications for the UPlan model. This may increase the runtime for these users. These automatic workarounds are as follows:

1. When creating base geometry centroids, they are created using the polygon's SHAPE@XY token within Python instead of the "Feature To Point" tool.

2. When calculating the constraint weights, the union tool is placed inside of a loop instead of unioning all constraints to the base geometry in one step (ArcEditor only allows the union of 2 layers at a time).

3. When calculating the attractor weights, the Euclidian Distance and Sample tools (Raster/Spatial Analyst tools) are used rather than the "Generate Near Table" tool.

3 – UPlan Components

3.1 Model Components

3.1.1 Time Steps

A UPlan run may be divided into multiple time steps. These will represent specified "break points" between the start date for the UPlan run, and the final end date. For example instead of running UPlan from 2015-2050 in a single step, it could be broken into 2015-2025, 2025-2035, and 2035-2050. Each of these time steps will have potentially independent population gains, general plans, constraints, and attracters in addition to the independent demand for each land use. It is possible to change settings such as the number of residences per acre that are called "high density" for each time step used however, this should be approached with caution because they are then not cross-comparable.

3.1.2 Subareas

The use of subareas allows subdivision of the new population and urban growth into various geographic areas within the study area boundary. Within each time step a distinct distribution of each land use into each subarea can be specified. For example "Subarea 1" could be forced to accommodate 50% of the new residential units, while "Subarea 2" receives 30% and "Subarea 3" gets 20%.

3.1.3 Base Geometry

This polygon feature class provides the minimum mapping units that UPlan will track. These may be derived from parcels, a grid that has been converted to vector format (also known as a Fishnet), voronoi polygons, or any other set of polygons that you wish to use. It is important to note that the size of these polygons should represent the level of detail you wish to achieve in your output allocation. Each feature in the Base Geometry layer must have a unique integer id assigned to it. When importing the Base Geometry layer into the UPlan geodatabase, a derivative feature class will be created that converts the polygons into a point dataset based on the polygon's centroids.

3.1.4 Demographic and Land Use Parameters

Land use classes represent either residential or employment areas. Their definition is made by the user. Residential land uses can account for vacant units. Land uses are permitted to develop in a user specified list of General Plan categories. The user can decide how many land use categories they want to include in the model.

Land consumption is calculated based on user-specific demographic and land use factors. These inputs are used to determine the number of acres demanded in each land use class for future growth. The conversion begins with a population projection for the entire study area. To determine acres demanded for future housing, the user specifies the average number of people per household. Then for each residential land use class, they assign what percentage of the total future households go into that class along with the average parcel size. To determine the area demanded for future employment space, the user specifies the average number of employees per household. Then for each employment land use class, they assign what percentage of the total future employees go into that class along with the average square foot per employee and the Floor Area Ratio (FAR). The model produces a table of acres demanded for each land use category from which the model operates its allocation routine.

3.1.5 Attractors

Attractors are used to prioritize where future urban growth will occur, and growth is allocated unit by unit from most attractive to least attractive location. It is assumed that the closer a vacant property is to a positive attraction layer, the more likely it will be developed in the future. For example, if a user uses an existing development layer as a positive attraction, then a property that is a quarter mile away from existing development is more desirable than one that is a mile away from the same location. Each land use can have independent attractors.

New in UPlan 4 is that an attractor can be either positive or negative. Negative attractors replace "discourager" layers from previous version of the model. Some features such as sensitive habitats, 100 year floodplains, and farmland might be developable at a high price tan therefore would have a negative attraction to growth. It is assumed that the closer a vacant property is to a negative attraction layer, the less likely it will be developed in the future.

Following these assumptions, the user assigns each attraction layer a series of distances and weights, called weight points. These weight points create a series of distance ranges and allow for the interpolation of weights between each pair of sequential points. For example, at a distance of 0 miles from the attractor the weight may be 20, at a distance of 1 mile the weight might be 10, and at a distance of 5 miles the weight might be 0. Since the weights are interpolated between points, any property whose centroid is within 5 miles of the attractor would be assigned an attraction value between 0 and 20 (Figure 3.1).

Weight Points

Distance	Weight
0	20
1	10
5	0

Figure 3.1 - Interpolation of Weight Points

For some attraction layers, it may not be appropriate to taper off the weights. In these cases, just assign the attraction a single weight point where distance equals 0. This will assign any base geometry centroid that falls within the attraction layer the assigned 0 distance weight; base geometry centroids that fall outside of the attraction layer would receive no weight.

For each polygon in the base geometry layer, the distance to each attractor is calculated. Then each land use's weight points are utilized to generate a weight for each attractor. The attractors are then summed for each land use to create a net attraction value.

3.1.6 Constraints

Constraints are new in UPlan 4 and they replace masks from previous versions of the model. A constraint layer defines a locale where the available space for development will be reduced as a percentage of the area, ranging between 1-100%. Constraints could be because of high slopes, presence of protected species, wetlands, undevelopable space or other reasons.

For example: a wetland constraint layer might have a 50% reduction in developable space and a lake constraint layer might have a 100% reduction in developable space. In these examples no future growth would be allocated to a lake, but up to half of the wetland area could be developed. In the wetland layer example, the wetland might occupy parts of 25 parcels. Because the wetland was given a 50% reduction, the extent of each parcel that overlaps with the wetland and that otherwise could be developed, is reduced by 50%. The area of each parcel not overlapping the wetland is fully available for development.

Constraint percentages are assigned to each land use. This allows for differences between land use types. When multiple constraints overlap, their constraints are summed; an overlapping 50% and 25% set of constraints would have a final effect of being a 75% reduction in developable space.

3.1.7 General Plans

A general plan layer defines where different land uses are permitted to be developed. Each time step can have an independent general plan layer or utilize different fields within the same general plan layer.

3.1.8 Mixed Use

For each general plan class, sets of land uses can be defined that are allowed to be allocated on top of each other. The final land use for that polygon will be the sum of the contributions from each land use that is permitted into that location.

3.1.9 Allocation of Future Growth

Spatial allocation of future growth is performed on one land use type at a time, the order is determined by the user. Each land use can be allocated based on the net attraction of the base geometry polygon or it can be allocated randomly. Where land uses are permitted to be allocated is based on the user defined crosswalk between land use types and general plan categories.

For each land use class, allocation begins by reducing the available polygons available for future growth in the base geometry layer based on the general plan code and any constraints they may have. UPlan then either uses the net attraction of the remaining polygons to allocate in order from most attractive to least or uses a random number generator to allocate. As the model is allocating growth to polygons, it is also recording and summing up the acreage of the polygons it is using. UPlan ends allocating growth to polygons when the total acreage has reached the acres demanded for that land use. If the model does not meet the demanded acreage, it reports the unallocated space to a table.

Allocation begins in the first time step and continues in chronological order through the remaining time steps. At the end of each time step 3 tables are produced: (1) a table that reports, by base geometry polygon, the number of acres allocated to each land use type in that time step; (2) a table that reports, by base geometry polygon, the cumulative number of acres allocated to each land use type in the current and any past time steps; (3) a table that reports, by SubArea and Land Use, the number of acres the model was unable to allocate. These tables are further explained in Appendix A.

3.1.10 Redevelopment

Redevelopment is an optional feature and allows the user to redevelop Base Geometry polygons and allocate the people and/or employees that are displaced. The redevelopment dataset indicates how many people currently live or work on each polygon. If development on these polygons is not prohibited by a constraint (or general plan), when those polygons are selected for development, the population and employment totals are added to a tally and a second (or third...) iteration of the allocation is done to accommodate those displaced.

3.2 User Interface

UPlan 4 has transitioned the model from one with a graphical user interface to one that is comprised of several python tools. These tools are contained within 7 toolsets. All of the tools are explained in Sections 4.2 – 4.8 of this manual.

3.3 Data Structure

All of the python files required for UPlan to run are contained in a single folder. Navigate to this folder in ArcCatalog and you will see the UPlan4.pyt toolbox containing all of the UPlan 4 toolsets and tools.

All of the tables and spatial data related to a UPlan run are contained in a single geodatabase. This database is created by the first tool in the UPlan4 python toolbox (section 4.2.1). The spatial data will vary depending on what data layers the user is using for their model run. There are many tables that UPlan uses to store settings, calculations, and outputs. These are automatically created, populated, and modified using the UPlan4 python toolbox, it is not recommended that the user edit these tables manually. Appendix A describes what is contained in these tables.

4 – Running UPlan

4.1 Model Setup

4.1.1 Installing NumPy and Pandas

To run UPlan there are a few installation steps that need to be completed first. The most technically complicated will be the installation of an updated version of NumPy and Pandas to your ArcGIS's Python installation. If you have unzipped the UPlan4 toolbox, but don't 4see any tools in ArcCatalog, it is probably due to not having installed NumPy and/or Pandas.

These instructions are written to focus on the 32bit install. If you are also doing the optional 64 bit installation, substitute ArcGIS10.3X64 for ArcGIS10.3 anywhere you see it occur in a file path. All of the steps including the pip installation needs to be done independently for the 32 and 64 bit installations. They are completely independent installations from each other.

NumPy is a key component of most scientific and numeric processing in Python. A version of it is installed with ArcGIS's Python installation, but the version (at least as of ArcGIS 10.2.2 and 10.3) is several versions behind the current version. Updating the NumPy version makes the installation of Pandas much easier, and I have not yet run into any compatibility problems with Arcpy or other Python libraries.

Pandas is a Python library that rests on top of NumPy and allows us to work with data tables in memory and vastly more efficiently than doing manipulations of the tables through Arcpy. Pandas is becoming a very commonly used library in Python, and Esri has suggested that it'll become a standard part of their default Python installation for ArcGIS in the future.

Installation Steps:

1. Download pip – a utility for managing the installation of Python libraries
    a. Download the get-pip.py file from https://pip.pypa.io/en/latest/installing.html
    b. Store this file at: *c:\Python27\ArcGIS10.3*
2. Install pip by opening the Command Line Prompt with Administrative Privileges
    a. Enter the following lines one by one, hitting enter at the end of each line
        i. cd c:\Python27\ArcGIS10.3
        ii. python.exe get-pip.py
    b. If you are asked for confirmation during the instillation of pip, please accept it
    c. The pip application will be installed into: *c:\Python27\ArcGIS10.2\Scripts*
3. Download NumPy
    a. Go to: http://www.lfd.uci.edu/~gohlke/pythonlibs/#numpy
    b. Download the current version of NumPy's .whl file
        i. It should look like: numpy-**<VersionNumber>**+mkl-cp27-none-win32.whl
        ii. Numpy version 1.10.4 is the current version as of January 2016, so the .whl file I would download today is: numpy-1.10.4+mkl-cp27-none-win32.whl
        iii. Store this file at: *c:\Python27\ArcGIS10.3\Scripts*
4. Download Pandas
    a. Go to: http://www.lfd.uci.edu/~gohlke/pythonlibs/#pandas
    b. Download the current version of Panda's .whl file
        i. It should look like: pandas-**<VersionNumber>**-cp27-none-win32.whl

ii. Pandas verion 0.17.1 is the current version as of January 2016, so the .whl file I would download today is: pandas-0.17.1-cp27-none-win32.whl
iii. Store this file at: *c:\Python27\ArcGIS10.3\Scripts*

5. Install NumPy and Pandas
    a. Open the Command Line Prompt with Administrative Privileges if you closed it after installing pip
    b. Close any ArcGIS programs that are open and any other application using Python
    c. Enter the following lines one by one, hitting enter at the end of each line. Substitute **<VersionNumber>** with the version number at the time of your installation. Navigate to *c:\Python27\ArcGIS10.3\Scripts* if you forgot what version you downloaded and get it from the .whl file names.
        i. cd c:\Python27\ArcGIS10.3\Scripts
        ii. pip.exe install numpy-**<VersionNumber>**+mkl-cp27-none-win32.whl
        iii. pip.exe install pandas-**<VersionNumber>**-cp27-none-win32.whl

4.1.2 Installing UPlan4 Toolbox

Copy the UPlan4Toolbox.zip zip file to a location on your workstation and unzip it. Now open ArcToolbox within either ArcMap or ArcCatalog (we recommend ArcCatalog because it's easier to drag and drop files into the tools). Right-click within the ArcToolbox window, select "Add Toolbox…", and navigate to the location where you unzipped the UPlan4Toolbox folder. There you will see the UPlan4.pyt toolbox containing all of the UPlan 4 tools (Figure 4.1). Click on the UPlan4.pyt toolbox and select "Open".

4.1.3 UPlan4 Toolbox Overview

All of the tools needed to setup and run UPlan are contained within a python toolbox. This file is named UPlan4.pyt and it contains 7 toolsets (Figure 4.1). If it's your first time running UPlan, the toolbox is designed to run sequentially from top to bottom. The tools contained in each of these 7 toolsets are explained in section 4.2 of this manual.

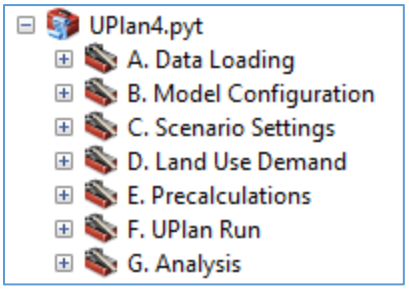

Figure 4.1 - UPlan 4 Toolbox

4.2 Data Loading Toolset

This section of the UPlan4 toolset contains the tools needed to create a UPlan geodatabase (UPGDB) and add the spatial data into that geodatabase. There are 7 tools in this toolset (Figure 4.2). The first creates the geodatabase, tools 2-6 are used to input the required spatial data, and the last tool is used to input an optional redevelopment table. Tools 2-6 can be used on a new UPGDB or an existing one. To use the toolset, open tools 1-6 sucessively and follow the instructions below. Tool 7 only needs to be run if the user would like to perform redevelopment. It is important not to load data into a UPGDB using ArcCatalog; use these tools.

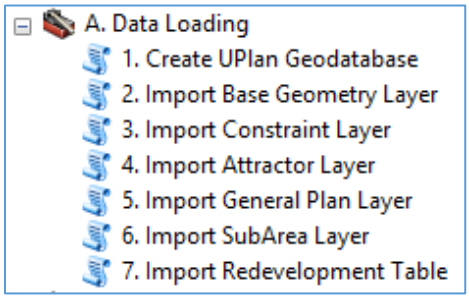

Figure 4.2 - Data Loading Toolset

4.2.1 Create UPlan Geodatabase

This tool allows the user to determine the name and location of the new UPGDB. The UPGDB will contain all of the input, intermediate, and output datasets for UPlan.

Tool steps:

1. In the top box, input the directory path to a folder you want to create a new UPGDB in. Do this by either dragging it from ArcCatalog or using the folder button to the right of the box. The location is a folder, and shouldn't be the UPlan4Toolbox folder that contains the python scripts.
2. Type in a name for the UPGDB. The name should not contain spaces (you can use an underscore instead) or special characters (!,@,#,\,/, etc.).

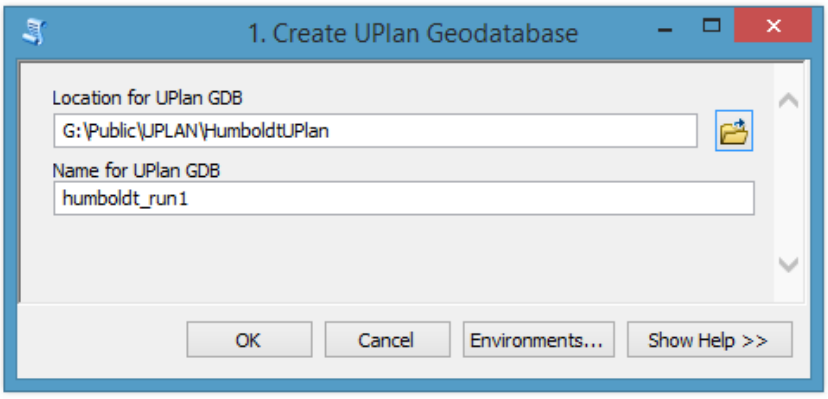

Figure 4.3 - Tool to create a UPlan Geodatabase

When this tool finishes running, you will have a UPGDB in the folder you selected that contains all of the required tables for a UPlan run. These tables are currently empty, but as you progress through the toolsets, they will update/fill these tables for you.

4.2.2 Import Base Geometry Layer

This tool is used to add the base geometry layer to the UPGDB. The base geometry layer is a polygon feature class that provides the minimum mapping units that UPlan will track. A full description for Base Geometry is available in section 3.1.3 of this manual. It also creates a centroid layer that will be used to assign base geometry polygons to: Sub Area(s), a General Plan category, Constraint(s), and distance to Attractor(s).

Tool steps:

1. Input the UPlan Geodatabase created in the first tool of this toolset. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the base geometry layer into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the base geometry layer you inputted in the second box. This name may contain spaces.
4. In the fourth box, click here if you would like the force the centroids inside of the base geometry polygons. The default is unchecked to get the most accurate distance calculations.

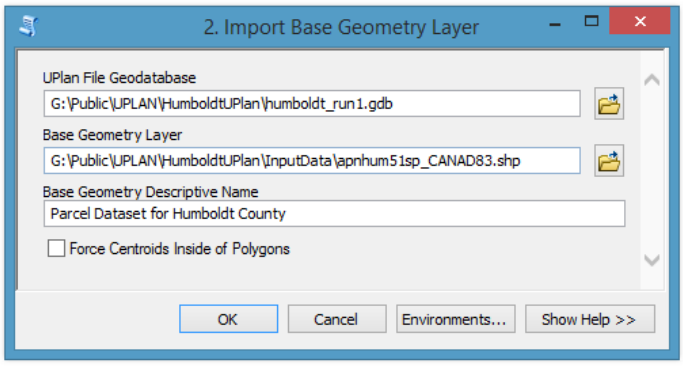

Figure 4.4 - Tool to Import a Base Geometry Layer

When this tool has finished running, several things will have happened:

1. The Base Geometry layer was added to the UPGDB and a new field, up_polyid, is created to store a unique ID for each polygon.
2. The centroids of the Base Geometry layer were created and contain the up_polyid field that was created in the previous step so the points can be joined back to the polygons.
3. The upc_layers table in the UPGDB has been updated with records for the new base geometry layer and the centroid layer.
4. The upc_key table has been updated with the 4 keys that relate to the base geometry layer: BaseGeom_bnd, BaseGeom_cent, BaseGeom_id, DistMode

4.2.3 Import Constraint Layer

This tool is used to add a constraint layer to the UPGDB. A constraint reduces the available space for development as a percent of the land area. A full description of a constraint layer is available in section 3.1.6 of this manual. Your UPlan run is likely to have more than one constraint, so you'll want to run this tool for each of them.

Tool steps:

1. Input the UPlan Geodatabase created in the first tool of this toolset. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the constraint layer into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the constraint layer you inputted in the second box. This name may contain spaces.

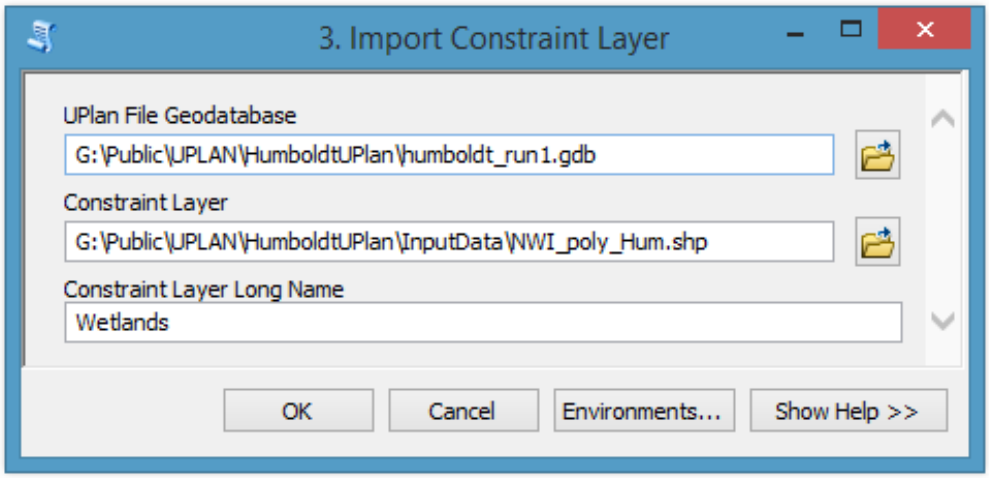

Figure 4.5 - Tool to Import a Constraint Layer

When this tool has finished running, the constraint layer will be added to your UPGDB and a row will be added to the upc_layers table.

4.2.4 Import Attractor Layer

This tool is used to add an attractor layer to the UPGDB. Attractors are used to prioritize where growth occurs when there is more space than required for a land use. A full description of an attractor layer is available in section 3.1.5 of this manual. Your UPlan run is likely to have more than one attractor, so you'll want to run this tool for each of them.

Tool steps:

1. Input the UPlan Geodatabase created in the first tool of this toolset. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the attractor layer into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the attractor layer you inputted in the second box. This name may contain spaces.

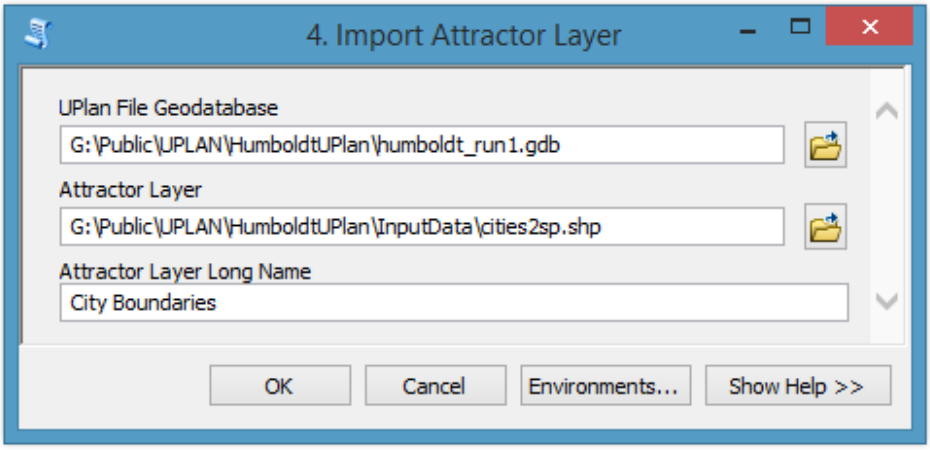

Figure 4.6 - Tool to Import an Attractor Layer

When this tool had finished running, the attractor layer will be added to your UPGDB and a row will be added to the upc_layers table.

4.2.5 Import General Plan Layer

This tool is used to add a general plan layer to the UPGDB. A general plan layer defines where land uses are permitted to develop. If you are doing a UPlan run with more than one time step, and they don't all use the same general plan, you'll want to run this tool for each general plan layer and assign them descriptive names that will allow you to distinguish between them.

Tool steps:

1. Input the UPlan Geodatabase created in the first tool of this toolset. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the general plan layer into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the general plan layer you inputted in the second box. This name may contain spaces.

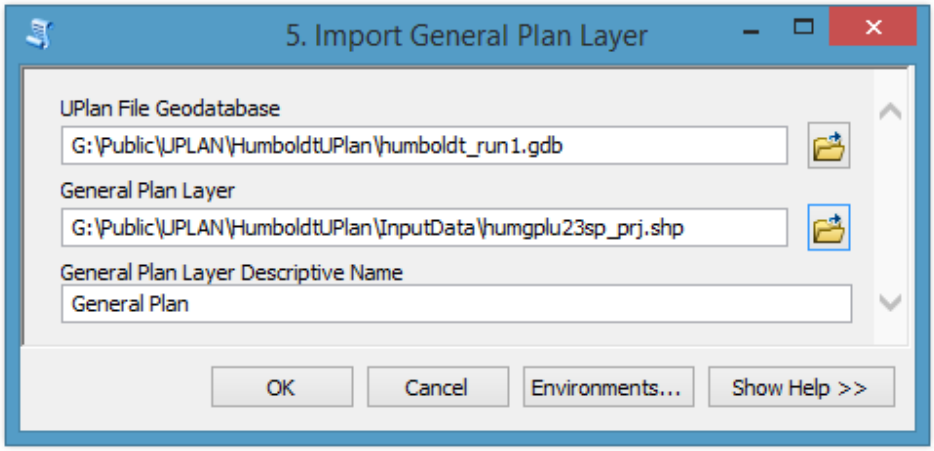

Figure 4.7 Tool to Import a General Plan Layer

When the tool finishes running, the general plan layer will be added to your UPGDB and a row will be added to the upc_layers table.

4.2.6 Import SubArea Layer

This tool is used to add a SubArea layer to the UPGDB. A subarea is a subsection of the model's geographic coverage that can have distinct control totals for population and employment assigned to it. The SubArea layer must contain 2 fields: one that has a unique ID for each SubArea and one that has a descriptive name for each SubArea. ***SubArea codes must start with a letter.***

A SubArea layer is required for UPlan to run so if you don't want to use SubAreas, just add a layer that has the same extent as your Base Geometry layer and assign the entire area with the same SubAreaID. For example, in Figure 4.8 I copied the county boundary, added a field titled 'said' and calculated all rows equal to 'sa1'. The county boundary already had a field that stored the county name, FMNAME_PC, so I used this as the field containing the SubArea Descriptive name.

Tool steps:

1. Input the UPlan Geodatabase created in the first tool of this toolset. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the SubArea layer into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the SubArea layer you inputted in the second box. This name may contain spaces.
4. Click in this box and select the field that contains the SubArea IDs. There should be a unique ID for each SubArea stored in this field.
5. Click in this box and select the field that contains the descriptive name for the SubArea IDs. There should be a 1 to 1 relationship between this field and the one selected in the box above.
6. Type in the maximum distance allowed between a Base Geometry centroid and the extent of the SubArea layer in order for that Base Geometry feature to be assigned to a SubArea. If the centroid is more than this distance, the Base Geometry feature will not be allocated future growth.

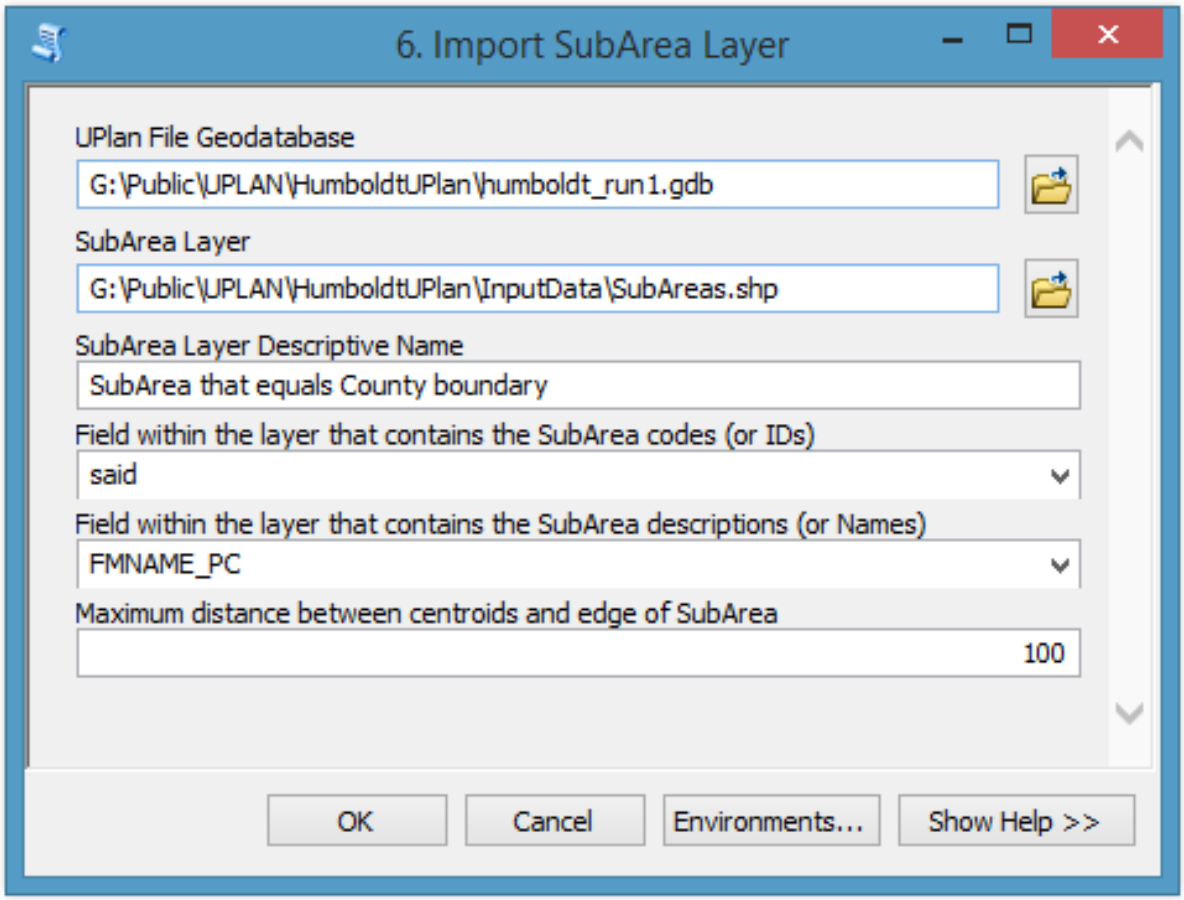

Figure 4.8 - Tool to Import a SubArea Layer

When the tool has finished running, the SubArea layer will be added to your UPGDB, a row will be added to the upc_layers table, and the upc_subareas table will be populated. The upc_key table will also be updated with: (1) the SubArea layer name; (2) the field name that contains the unique SubArea codes (or IDs); (3) the maximum distance parameter.

4.2.7 Import Redevelopment Table

This tool is used to add a redevelopment table to the UPGDB. A redevelopment table requires 3 things: (1) a field named 'up_polyid' of type Long Integer that contains the unique polygon ID of the base geometry layer (created when a Base Geometry layer was added to the UPGDB); (2) a field that contains the number of people currently residing in that polygon; (3) a field that contains the number of employees currently working in that polygon.

Tool steps:

1. Input the UPlan Geodatabase created in the first tool of this toolset. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the redevelopment table into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the redevelopment table you inputted in the second box. This name may contain spaces.
4. Click in this box and select the field that contains the population total.
5. Click in this box and select the field that contains the employment total.

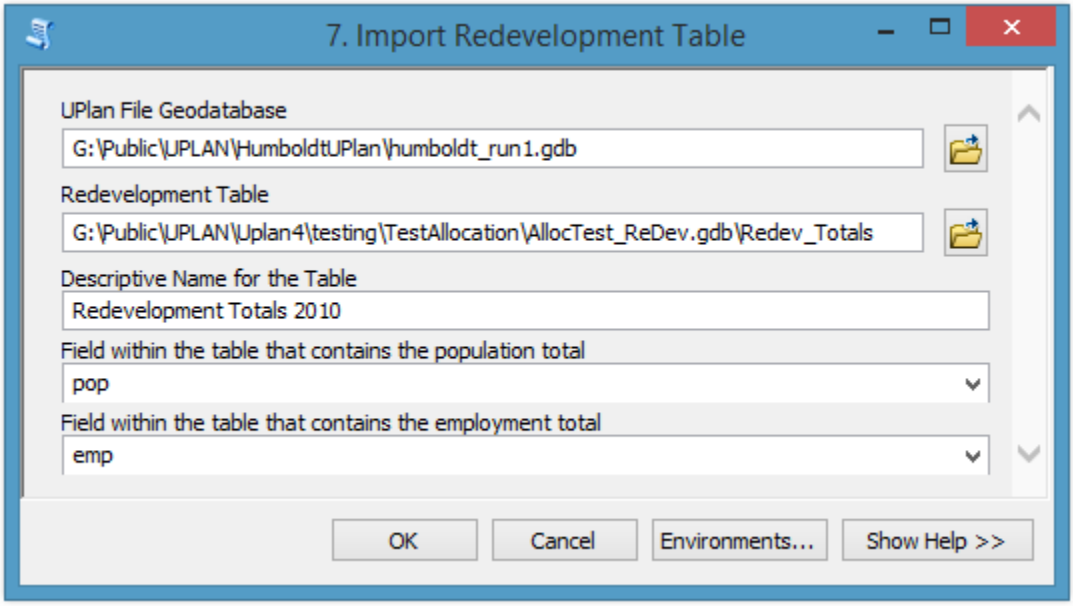

Figure 4.9 – Tool to Import a Redevelopment Table

When the tool has finished running, the redevelopment table will be added to your UPGDB and a row will be added to the upc_layers table. The upc_key table will also be updated with: (1) the name of the redevelopment table; (2) the field name that contains the population total; (3) the field name that contains the employment total.

4.3 Model Configuration Toolset

This section of the UPlan4 toolset contains the tools needed to setup or modify time steps and land uses. These tools can be run as many times as the user needs. The first 2 tools are used to add and remove time steps. Tools 3-5 are used to add and remove land uses, as well as set the order that land uses will be allocated. The user can have as many time steps and land uses as they like; at a minimum one time step, one employment land use, and one residential and use are required for UPlan to run.

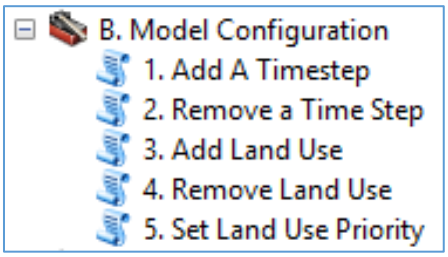

Figure 4.10 – Model Configuration Toolbox

4.3.1 Add a Time step

This tool is used to add a time step to the UPGDB. A time step allows the specification of almost all UPlan settings to be applied for a specific range of years. A full description of a time step is available in section 3.1.1 of this manual. A UPlan run needs at least one time step.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, type in a descriptive name for the time step you want to add. This name may contain spaces.
3. In the third box, type in a code for the time step you want to add. The code should start with a letter and not contain any spaces or special characters (!,@,#,\,/, etc.).
4. In the fourth box, type in the numerical position of the time step you are adding. If this is the first time step you are adding to a UPlan run, the position is 1. If this isn't the first time step you are adding to a UPlan run, enter the number that represents the chronological order you want to add this time step at, relative to the existing time steps.
5. In the fifth box, select the general plan layer to be used for this time step. If the general plan layer you want to use is not listed, add it to the UPGDB using the Import General Plan Layer tool.
6. In the sixth box, select a field within the general plan layer selected in the fifth box that contains the general plan codes you want to use for this time step.

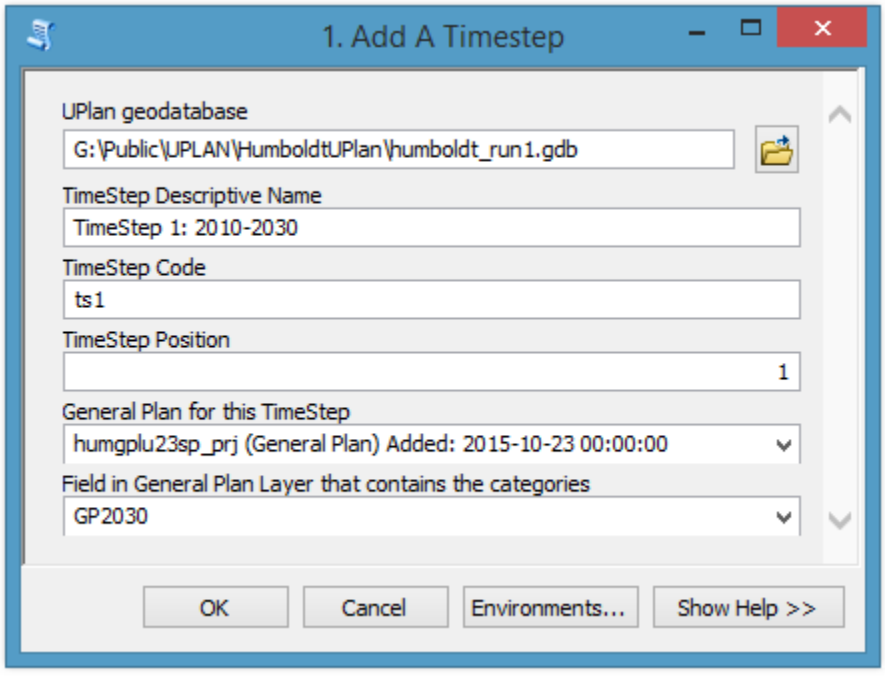

Figure 4.11 - Tool to add a time step

When this tool has finished running, a time step will be added to your UPlan model and the upc_timesteps table will be updated.

4.3.2 Remove a Time Step

This tool is used to remove a time step from the UPGDB. It also removes all of the settings for the selected time step (attractors and their weights, constraints, general plan layer and the land uses that are allowed in each general plan category, allowed mixed use pairs, and space demanded for each land use).

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Selected the time step you would like to remove.

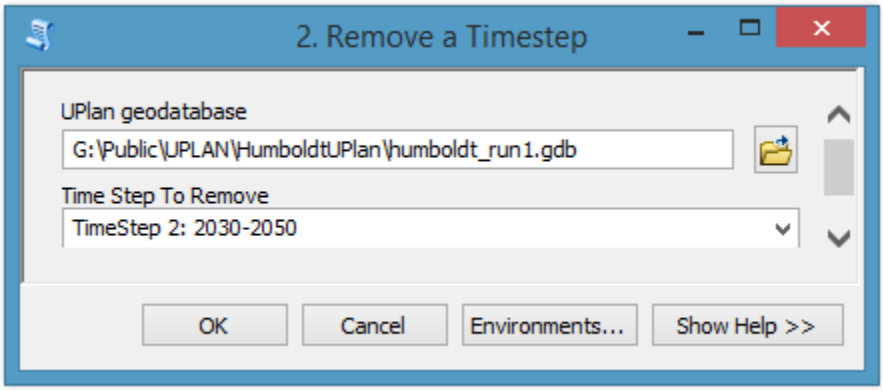

Figure 4.12 - Tool to Remove a Time Step

When this tool has finished running, the selected time step will be removed from the upc_timesteps table and all of the settings for the time step will be removed from the UPGDB.

4.3.3 Add Land Use

This tool is used to add a land use type to the UPGDB. A land use is either residential or employment and allows for some portion of vacant space. A full description of a land use is available in section 3.1.4 of this manual. A UPlan run needs at least one residential and one employment land use. However, the user can define as many land use types as are needed for their run. In many cases these can be summarized as: Residential High Density (rh); Residential Medium Density (rm); Residentail Low Density (rl); Rural Residentail (rvl); Retail (ret); Commercial (com); Industrial (ind). These are the land uses that will be used in this manual.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, type in a code for the land use you want to add. The code should start with a letter and not contain any spaces or special characters (!,@,#,\,/, etc.).
3. In the third box, type in a descriptive name for the land use you want to add. This name may contain spaces.
4. In the fourth box, selected the type of land use you are adding, either residential or employment.
5. In the fifth box, select the allocation mode for this land use. Normal means that the land use will be allocated based on net attraction, random means that the land use will be allocated randomly. See section 3.1.9 of this manual for a description of these two allocation modes.

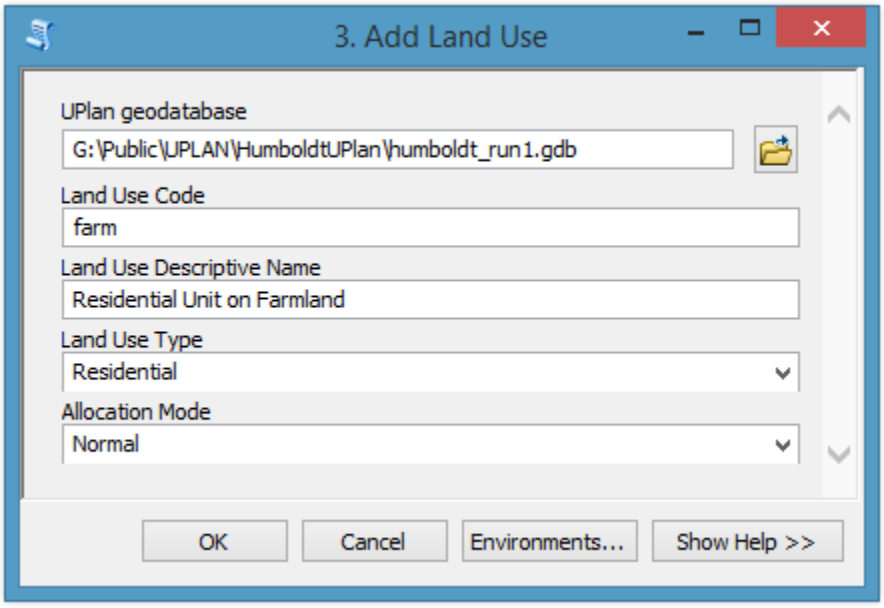

Figure 4.13 - Tool to Add a Land Use

When this tool has finished running, the upc_lu and upc_demand tables will be updated. The land use added by this tool is assigned the lowest priority, to change this use the Set Land Use Priority tool. Use the Land Use Demand Toolset to set the space requirements and calculate the demand for this land use to be used for allocation (section 4.5 of this manual).

4.3.4 Remove Land Use

This tool is used to remove a land use from your UPGDB. It also removes all of the settings for the selected land use (acres demanded, general plan crosswalk, constraint and attractor weights).

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Selected the land use you would like to remove.

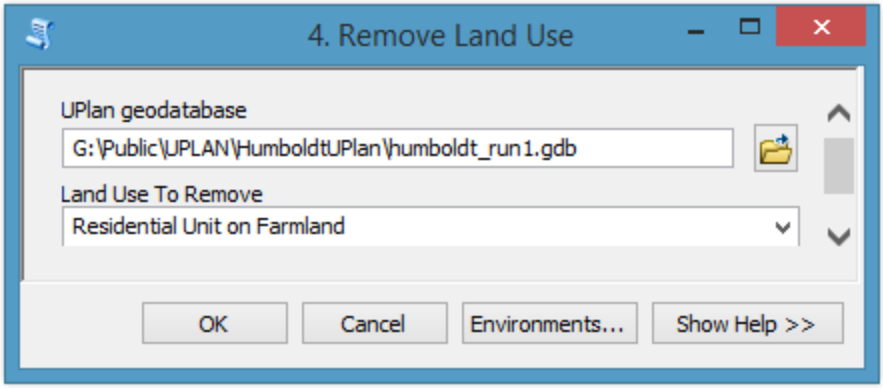

Figure 4.14 - Tool to Remove a Land Use

When this tool has finished running, the selected land use will be removed from the upc_lu table and all of the settings for the land use will be removed from the UPGDB.

4.3.5 Set Land Use Priority

This tool is used to set the order in which land uses are allocated. The land use with the highest priority is assigned to the base geometry polygons first, then the land use with the second highest priority is assigned, then the third, etc.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. After adding the UPGDB, all of the land use names will be displayed. Highlight the land use you want to change and use the up and/or down arrows to change its priority. Do not use the add or remove buttons. The land use on top of the list has the highest priority and will be allocated first; the land use on the bottom of the list has the lowest priority and will be allocated last.

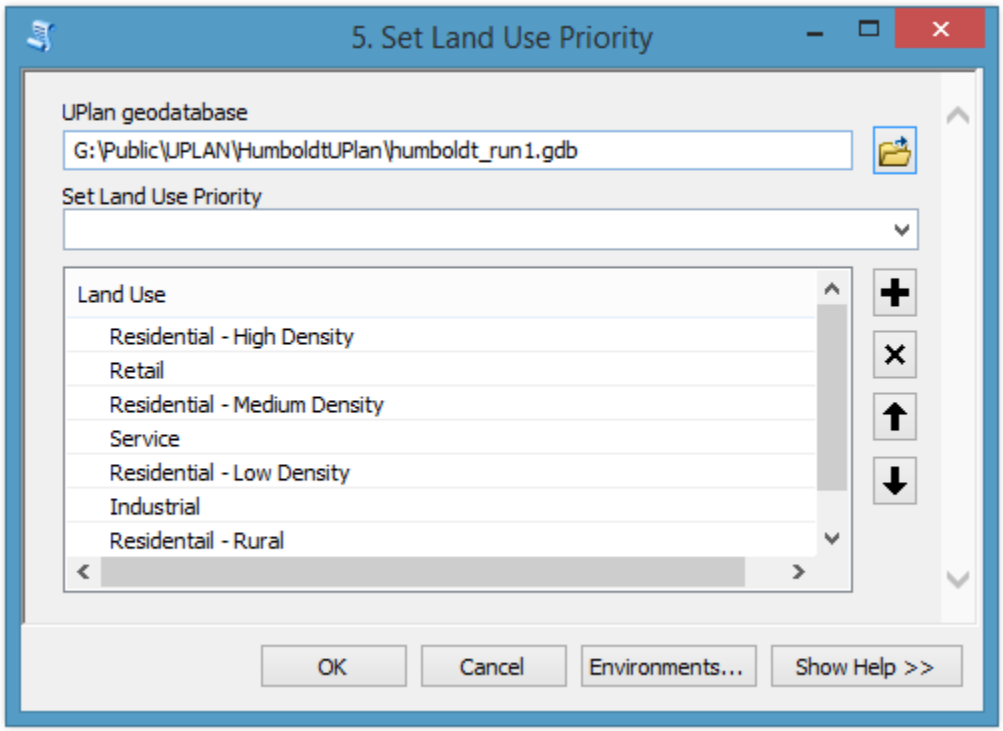

Figure 4.15 - Tool to Set Allocation Priority for all Land Uses

When this tool has finished running, the order of the land uses in the upc_lu table will be updated.

4.4 Scenario Settings Toolset

This section of the UPlan4 toolset contains the tools needed to setup or update the UPlan settings. The first two tools are used to assign an attraction layer to a land use and set the weights for it. Tools 3-4 are similar and are used to assign a constraint layer to a land use and set the constraint percentage. The 5th tool is used to update the general plan that is associated with a time step. The 6th tool creates or edits the crosswalk between land use codes and general plan categories, informing the model of what general plan categories a land use is allowed to be allocated to. The final tool is used to set or edit combinations of land uses that are allowed in mixed use categories, informing the model of what land uses can be allocated on top of each other.

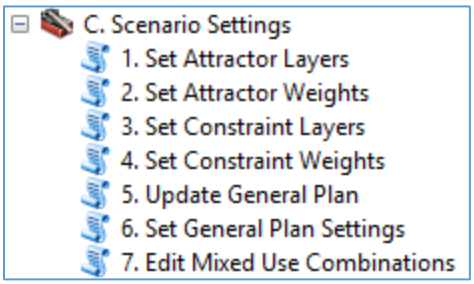

Figure 4.16 – Scenario Settings Toolbox

4.4.1 Set Attractor Layers

This tool is used to determine which attractors are available to each time step. The attraction layer(s) must first be added to the UPGDB using the Import Attractor Layer tool outlined in section 4.2.4 of this manual.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit the available attractor layers for.
3. After selecting a time step, all attractors and their availability will be listed. To change the availability, type either "No" or "Yes" in the 3rd column. Do not use the add or remove buttons.

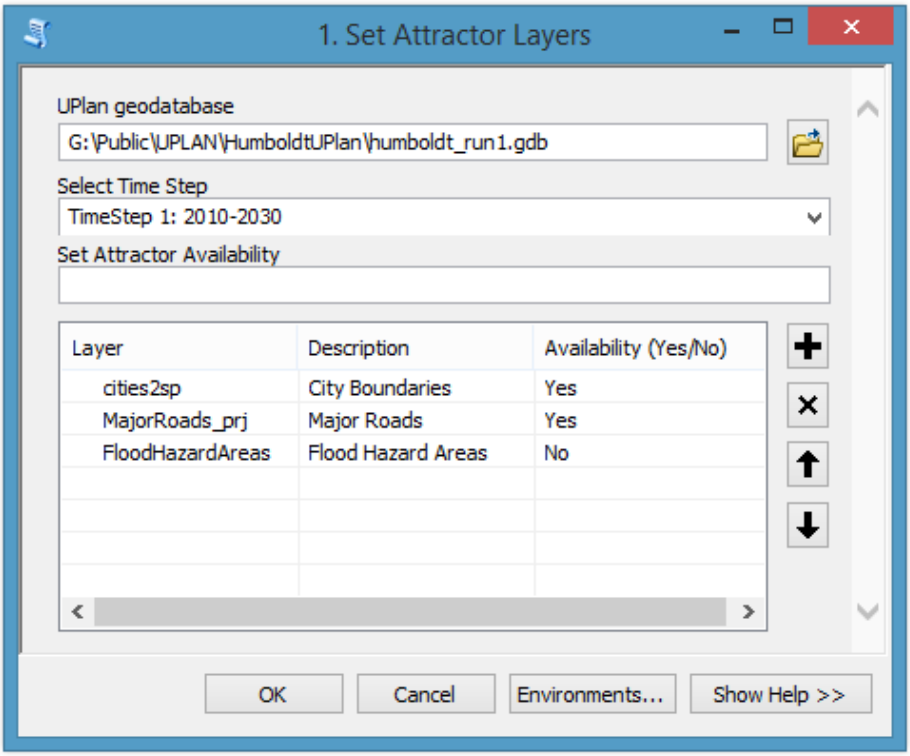

Figure 4.17 - Tool to Set Attractor Availability

When this tool has finished running, the upc_attractors table will be updated.

4.4.2 Set Attractor Weights

This tool is used to set weights for attractor layers. Attractor weights are explained in section 3.1.5 of this manual and an example of weight points that this tool creates are displayed in Figure 3.1. Each land use type that was created with allocation mode equal to 'Normal' in the Add Land Use Tool (section 4.3.3) needs at least one attractor with weights in each time step for UPlan to run. If you would not like to use attraction layers for a land use, remove it (section 4.3.4) and then re add it (section 4.3.3) and set the Allocation Mode equal to 'Random'.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. In the third box, select the land use you'd like to edit the weights for.
4. In the fourth box, select the attraction layer you'd like to edit the weights for. If the attraction layer you want to edit isn't listed, use the Set Attractor Layers tool to make it available (section 4.4.1)
5. After selecting an attractor layer, the attraction weights will be displayed in the table on the bottom of the tool. You can edit the values in the table by clicking on them. To add a new weight, type a distance in the box above the table and click on the '+' button. To remove a weight, highlight the weight you'd like to remove and click on the 'x' button.

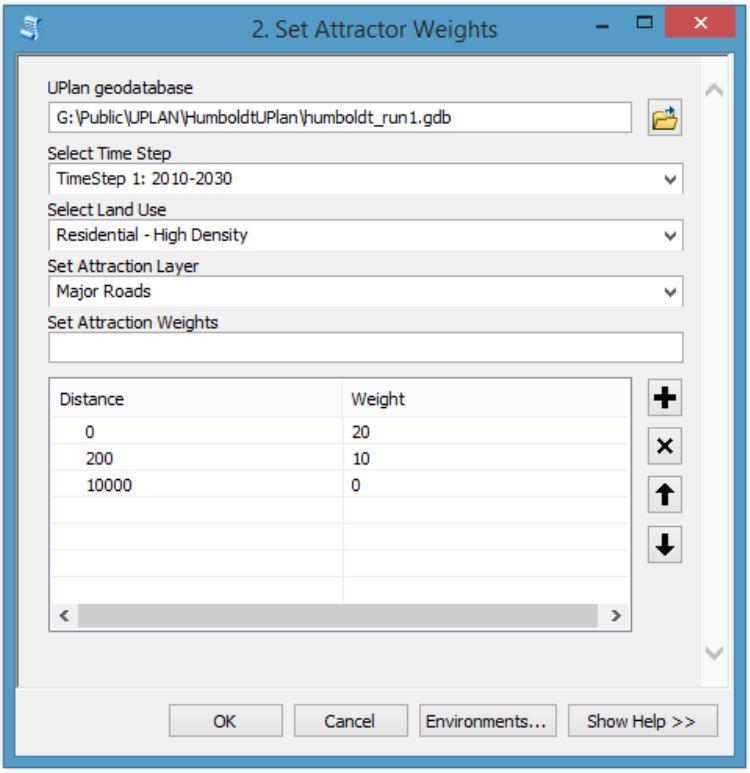

Figure 4.18 - Tool to Set Attractor Weight(s)

When this tool has finished running, the upc_aweights table will be updated.

4.4.3 Set Constraint Layers

This tool is used to determine which constraints are available to each time step. The constraint layer(s) must first be added to the UPGDB using the Import Constraint Layer tool outlined in section 4.2.3 of this manual.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit the available constraint layers for.
3. After selecting a time step, all constraints and their availability will be listed. To change the availability, type either "No" or "Yes" in the 3rd column. Do not use the add or remove buttons.

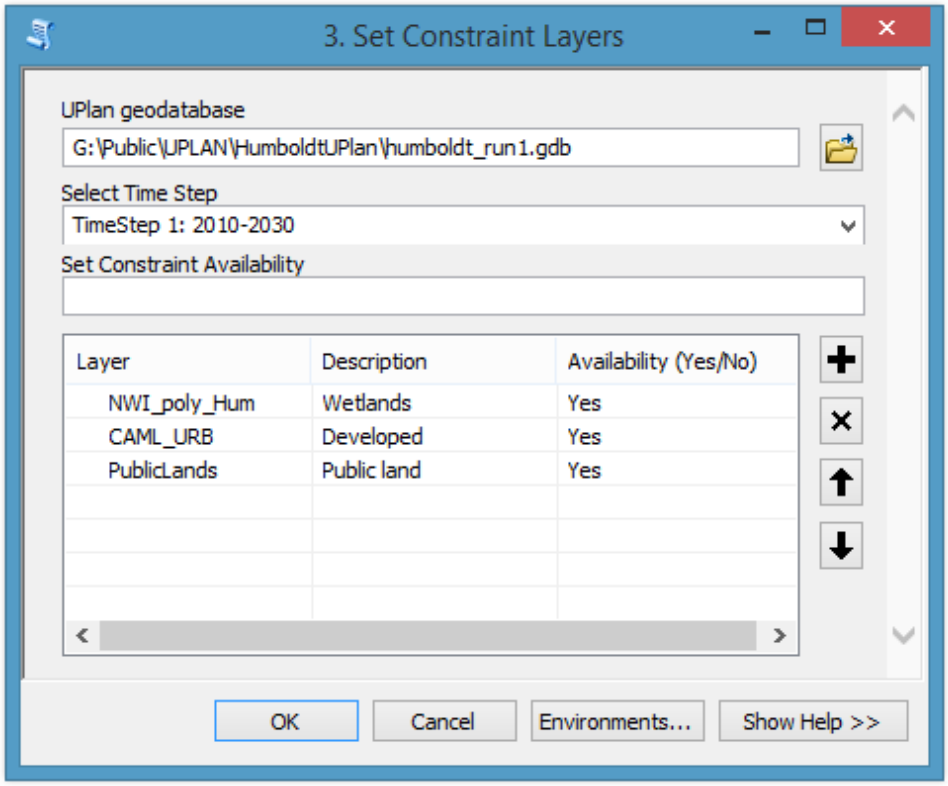

Figure 4.19 - Tool to set constraint availability

When this tool has finished running, the upc_constraints table will be updated.

4.4.4 Set Constraint Weights

This tool is used to set the weight for constraint layers. A constraint reduces the available space for development as a percent of the land area. A full description of a constraint layer is available in section 3.1.6 of this manual. Constraint weights can range from 0 to 100 percent. Each land use type within each time step needs at least one constraint with weights for UPlan to run.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. In the third box, select the land use you'd like to edit the weight(s) for.
4. After selecting a land use, the constraint layer(s) and their weight(s) will be displayed in the table at the bottom of the tool. If the constraint layer you want to edit isn't listed, use the Set Constraint Layers tool to make it available (section 4.4.3). You can edit the values in the table by clicking on them. A constraint value of 100 means that 100% of the area is constrained (and therefore, no new development is allowed). A constraint value of 25 means that 25% of the area is constrained (and therefore, only 75% of the area can be developed). Do not use any of the buttons to the right of the table.

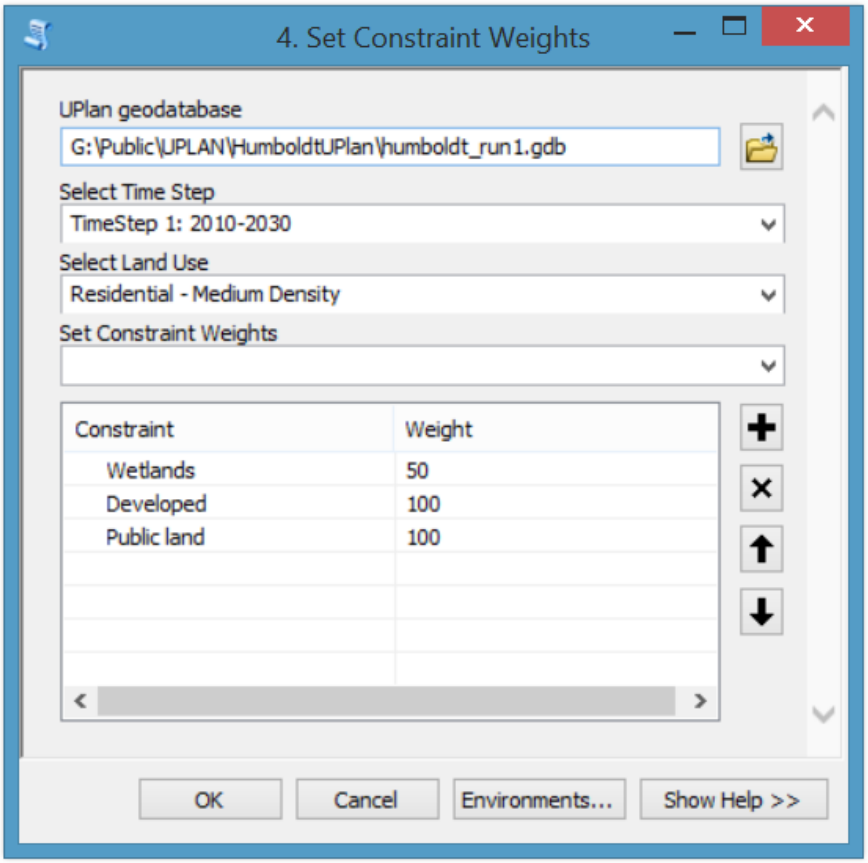

Figure 4.20 - Tool to Set Constraint Weight(s)

When this tool has finished running, the upc_cweights table will be updated.

4.4.5 Update General Plan

This tool is optional. It changes the general plan assigned to a time step.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. In the third box, select the general plan you'd like to assign to the time step selected in the box above.
4. In the fourth box, select the field within the general plan layer selected in the box above that contains the general plan codes you'd like to use for the selected time step.

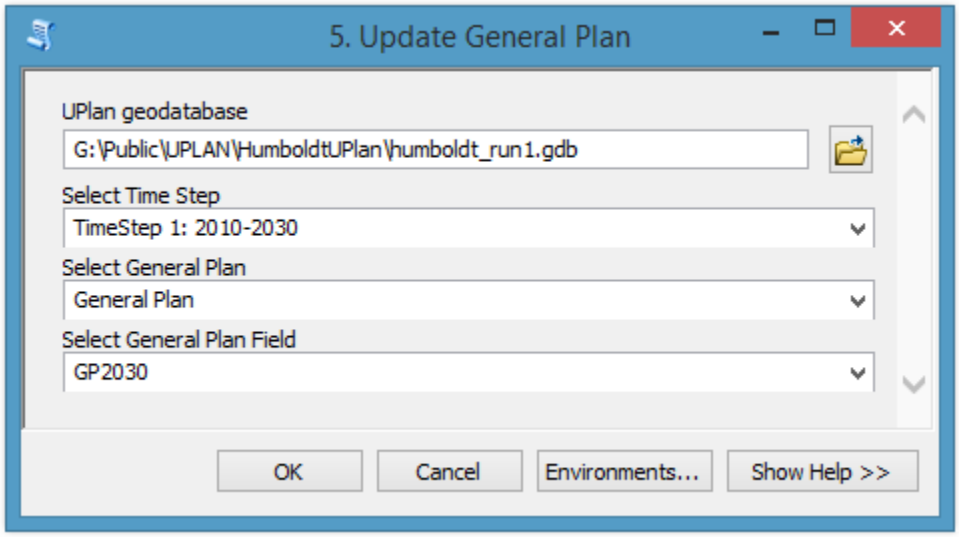

Figure 4.21 – Tool to Update the General Plan Layer Assigned to a Time Step

When this tool has finished running, the upc_timesteps table will be updated.

4.4.6 Set General Plan Settings

This tool sets the general plan categories that a given land use can be assigned to.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. In the third box, select the land use you'd like to edit the available general plan categories for.
4. After selecting a land use, all general plan categories will be listed in the table at the bottom of the tool. Set the availability of each general plan category by typing 'No' or 'Yes' in the availability column.

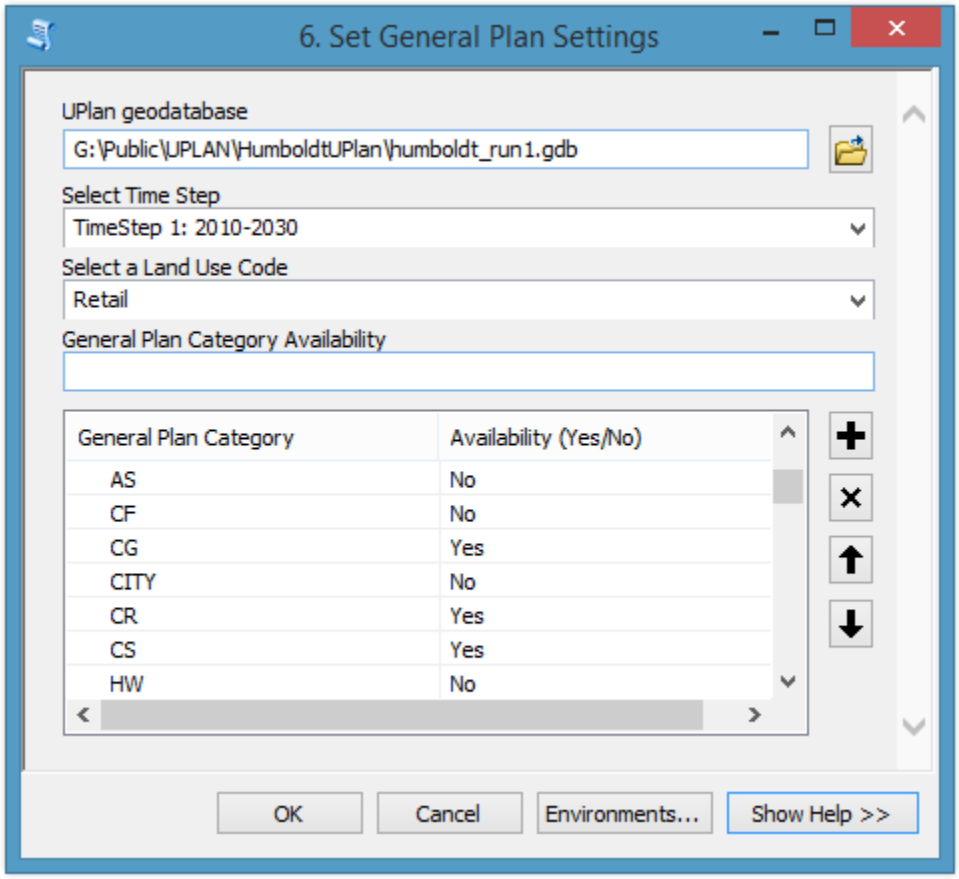

Figure 4.22 – Tool to Set the Available General Plan Categories a Land Use Can be Allocated into

When this tool has finished running, the upc_gplu table will be updated.

4.4.7 Edit Mixed Use Combinations

For each general plan category, this tool creates or edits a set of land uses that may be allocated on top of each other. These land uses will not block each other during allocation.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. In the third box, select the general plan code you'd like to edit the allowable mixed use land uses for.
4. After selecting a general plan category, existing mixed use combinations will be listed in the 4th menu. To edit an existing combination, select it from the drop down menu; to create a new combination, select 'Ceate a New Combination' from the drop down menu.
5. After selecting a mixed use combination to edit, set the availability of each land use type by typing 'No' or 'Yes' in the availability column. Land uses with a 'Yes' will be allowed to allocate on top of each other. Putting 'No' for all LUNames will remove that mixed use combination from the UPGDB.

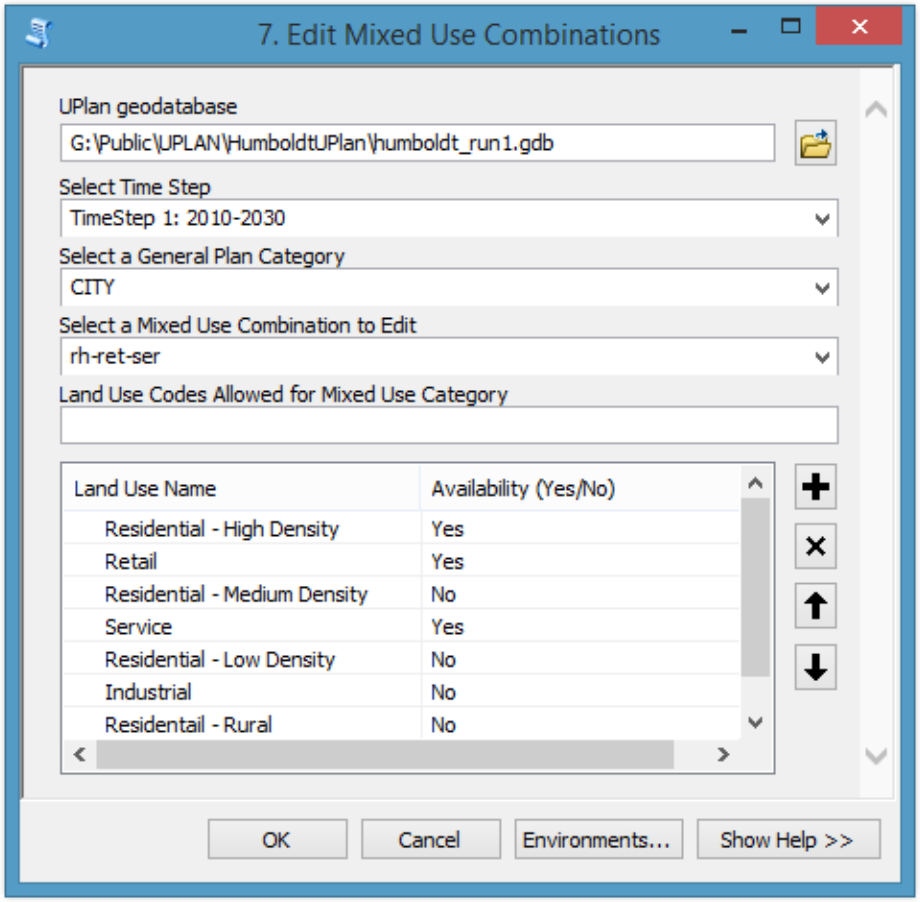

Figure 4.23 – Tool to Add , Edit, or Remove a Mixed Use Combination

When this tool has finished running, the upc_mu table will be updated.

4.5 Land Use Demand Toolset

This section of the UPlan4 toolset contains the tools needed to setup or update the UPlan demand settings. These settings are used to convert population growth to demanded households and employment space. Tools 1-6 need to be ran for each time step. The first tool sets population growth and the conversion factors to convert future population to number of households and employees. Tools 2-3 set the space requirements for each land use type; tool 2 for residential types and tool 3 for employment types. The 4th tool sets the percentage of future households and employees that will be allocated into each SubArea. Tool 5 sets the percentage of future households that will be allocated into each residential land use type. Tool 6 sets the percentage of future employees that will be allocated into each employment land use type. After tools 1-6 have been run for all time steps, the 7th tool takes all of the UPlan demand settings and calculates space demanded in each SubArea by land use type and time step.

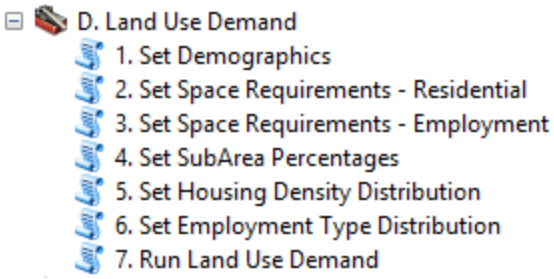

Figure 4.24 – Land Use Demand Toolbox

4.5.1 Set Demographics

This tool is used to set the basic demographic inputs for each time step.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit the demographic settings for.
3. In the third box, input or edit the base population. This is the population at the beginning of the time step.
4. In the fourth box, input or edit the future population. This is the population at the end of the time step.
5. In the fifth box, input or edit the persons per household conversion factor. This is the average number of people per household.
6. In the sixth box, input or edit the employees per household conversion factor. This is the average number of employees per household

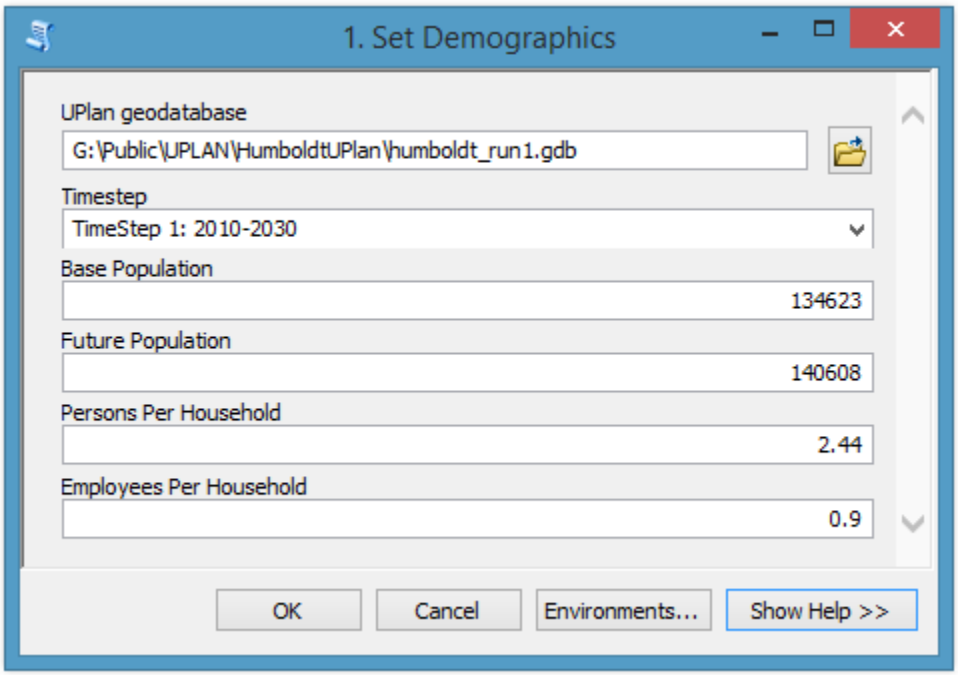

Figure 4.25 – Tool to Set Demographic Settings for a Time Step.

When this tool has finished running, the upd_demographics table will be updated.

4.5.2 Set Space Requirements – Residential

For each time step, this tool sets the space requirements for all residential land use types.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit or set the residential space parameters for.
3. After selecting a time step, all residential land use types will be listed in the table at the bottom of the tool. To the right of the column containing the land use codes, are 3 columns displaying the settings for each land use type. Click into these columns to edit the values. Do not use the buttons to the right of the table. The 3 settings for residential space requirements are:
    a. Acres Per Unit – The average number of acres per unit/household within the land use
    b. Percent Vacant – The average percentage of vacant housing units within the land use
    c. Percent Other Space – The average percentage of other space within the land use

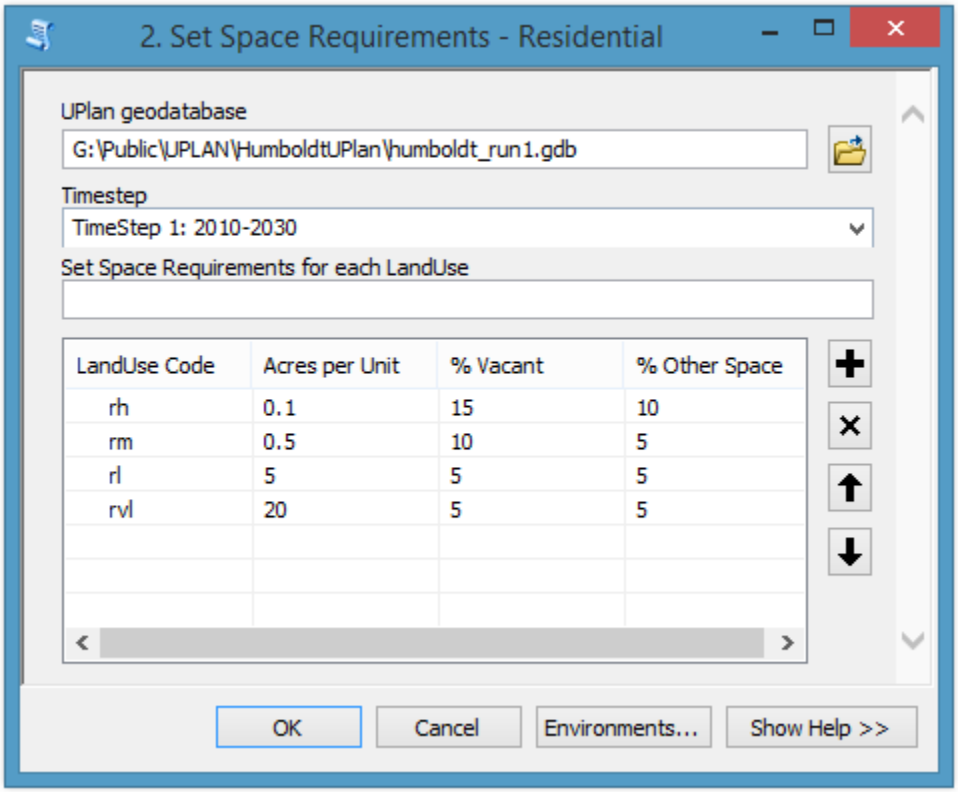

Figure 4.26 – Tool to Set the Space Requirements for Residential Land Use Types

When this tool has finished running, the upd_rescalcs and upd_reslanduses tables will be updated.

4.5.3 Set Space Requirements – Employment

For each time step, this tool sets the space requirements for all employment land use types.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit or set the employment space parameters for.
3. After selecting a time step, all employment land use types will be listed in the table at the bottom of the tool. To the right of the column containing the land use codes, are 3 columns displaying the settings for each land use type. Click into these columns to edit the values. Do not use the buttons to the right of the table. The 3 settings for employment space requirements are:
    a. Square Feet Per Employee – The average number of square feet per employee within the land use
    b. FAR – The average Floor Area Ratio within the land use
        i. The total area of a building divided by the total area of the lot the building is located on
    c. Percent Other Space – The average percentage of other space within the land use

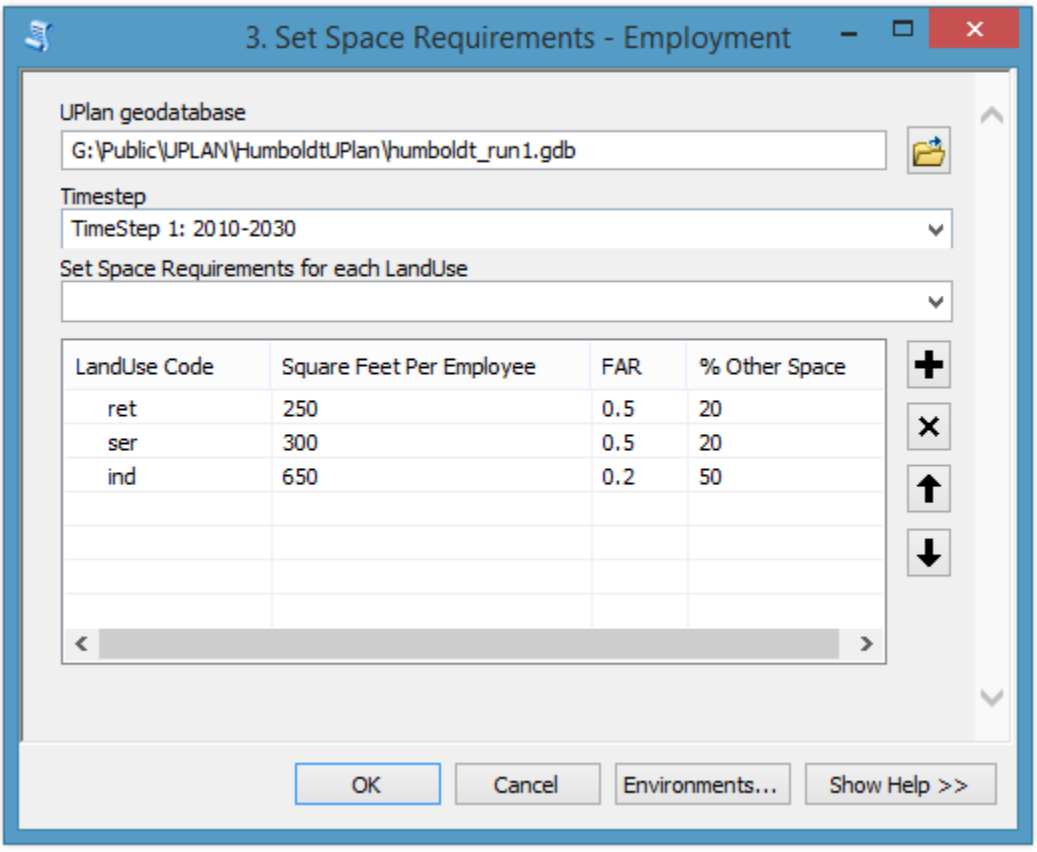

Figure 4.27 – Tool to Set the Space Requirements for Employment Land Use Types

When this tool has finished running, the upd_empcalcs and upd_emplanduses tables will be updated.

4.5.4 Set SubArea Percentages

For each time step, this tool sets the percentage of the future population and the percentage of the future employees that will be allocated into each SubArea. If the run you are setting up doesn't have SubAreas (and you added the study area boundary as the 'SubArea' in the Data Loading Toolbox) set both percentages to 100 (Figure 4.28a). If the run you are setting up has SubAreas, set the percentages for population and employees that you want allocated to each SubArea between 0-100 (Figure 4.28b). Each column must sum to 100.

Tools steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. After selecting a time step, all SubAreas will be listed in the table at the bottom of the tool. Edit the percentages of people and employees to distribute between the SubAreas. Do not use the buttons to the right of the table. The columns must sum to 100.

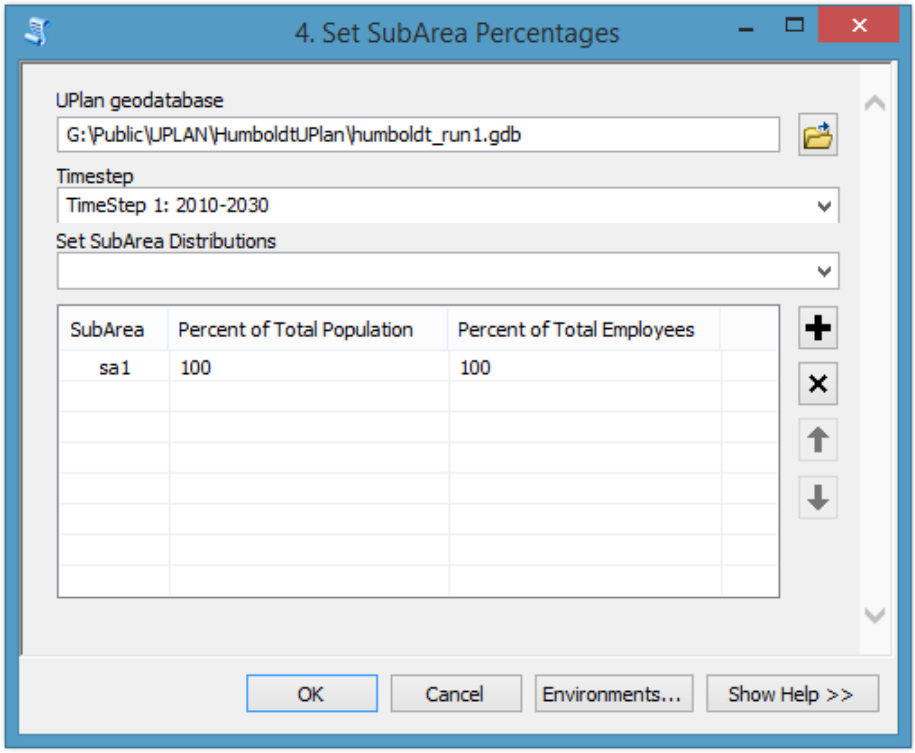

Figure 4.28a – Tool to Set the Number of People and Employees that will be Allocated to Each SubArea. In this example, the UPlan run only has 1 SubArea.

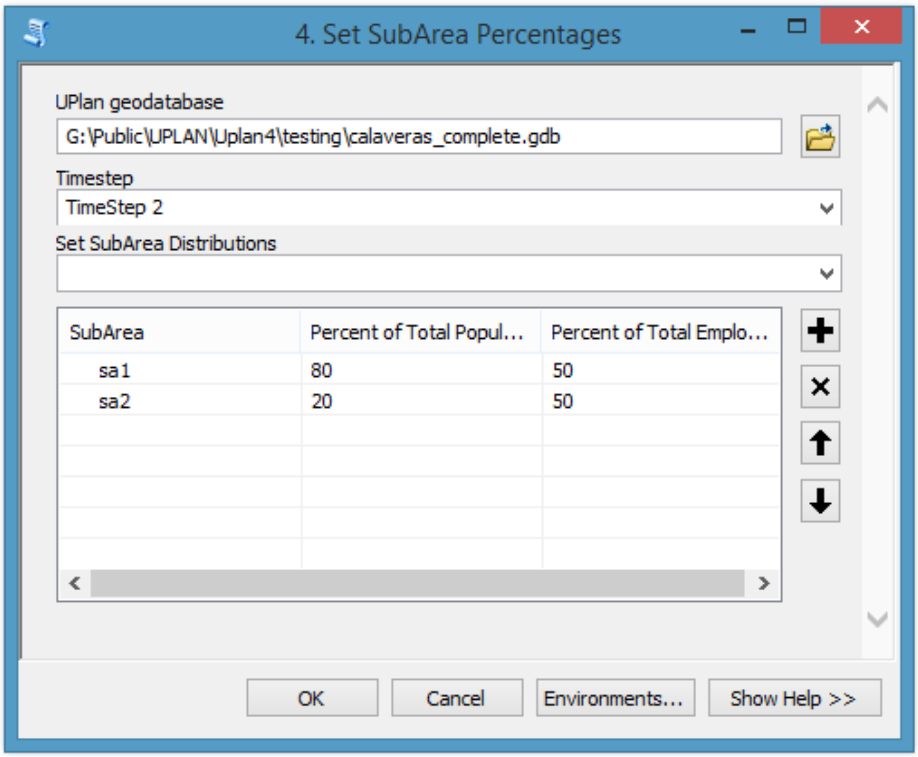

Figure 4.28b – Tool to Set the Number of People and Employees that will be Allocated to Each SubArea. In this example, the UPlan run has 2 SubAreas.

When this tool has finished running, the upd_subareademand table will be updated.

4.5.5 Set Housing Density Distribution

For each time step, this tool sets the percentage of households to be allocated into each residential land use type for each sub area. The percentage of households column must sum to 100 for each SubArea.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. After selecting a time step, the table at the bottom of the tool will be updated with the current distributions. For each SubArea, edit the values in the third column to set the percentage of future households that will be assigned to each land use class; these percentages should sum to 100. Do not use the buttons to the right of the table.

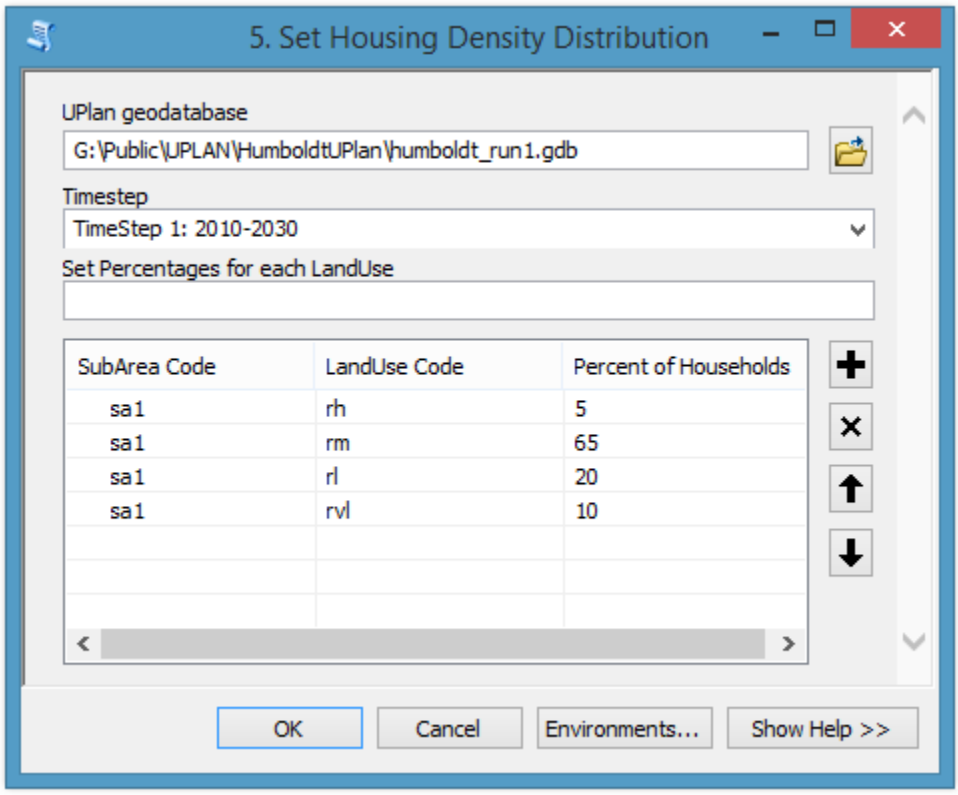

Figure 4.29 – Tool to Set or Edit the Housing Density Distribution

When this tool has finished running, the upd_subareares table will be updated.

4.5.6 Set Employment Type Distribution

For each time step, this tool sets the percentage of employees to be allocated into each employment land use type for each sub area. The percent of employees column must sum to 100 for each SubArea.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. In the second box, select the time step you'd like to edit.
3. After selecting a time step, the table at the bottom of the tool will be updated with the current distributions. For each SubArea, edit the values in the third column to set the percentage of future employees that will be assigned to each land use class; these percentages should sum to 100. Do not use the buttons to the right of the table.

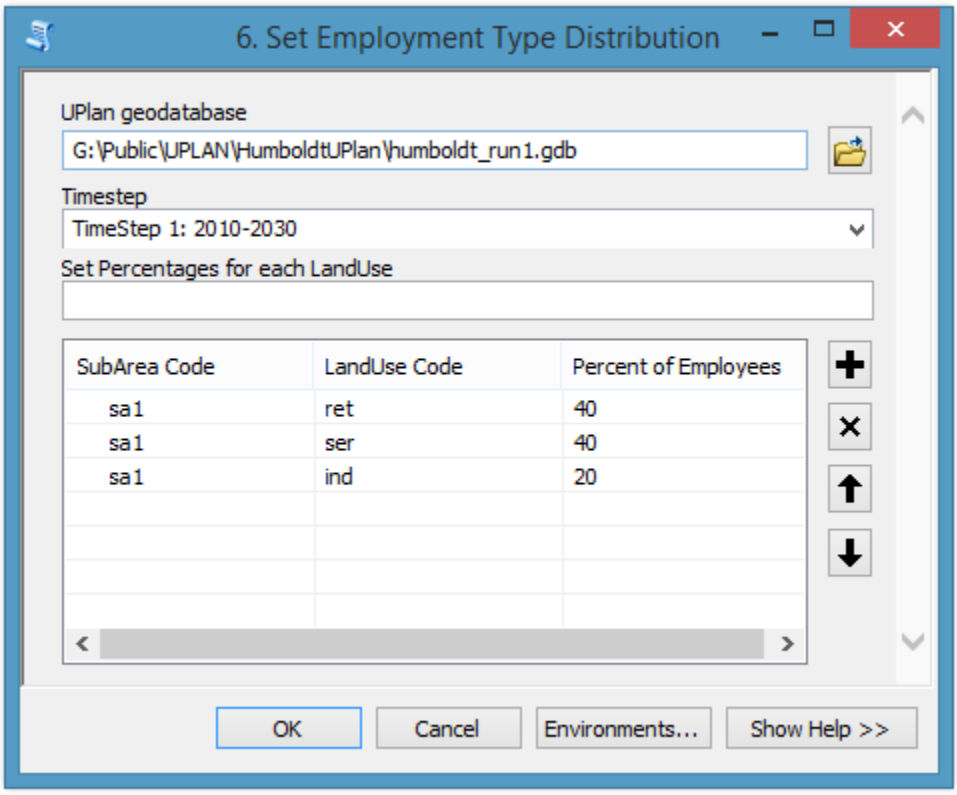

Figure 4.30 – Tool to Set or Edit the Employment Type Distribution

When this tool has finished running, the upd_subareaemp table will be updated.

4.5.7 Run Land Use Demand

This tool will calculate the number of employees and number of households demanded for each SubArea within each time step. Run this tool after you have completed tools 1-6 in this section for each time step, or if you have made a change to the demand inputs in tool(s) 1-6.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.

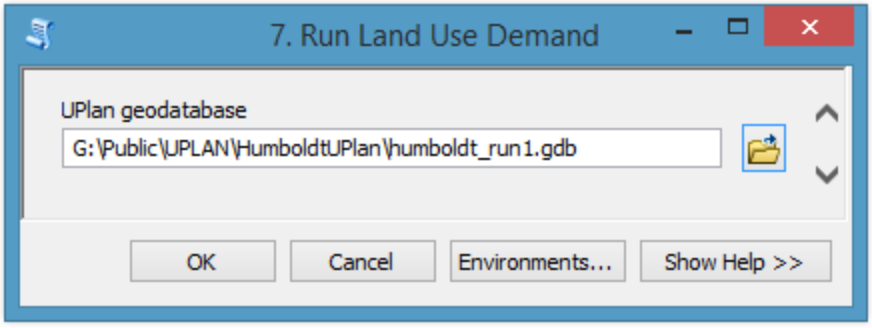

Figure 4.31 – Tool to Run the Land Use Demand Calculations

When this tool has finished running, the upc_demand table will be updated.

4.6 Precalculations Toolset

This section of the UPlan4 toolset contains the tools needed to do the precalculations before performing allocation. The first tool runs all of the calculations UPlan requires, so if this tool is run none of the others in the toolset need to be ran. The other 4 tools break out the 4 main calculations. The second tool assigns all base geometry polygons to a SubArea. The third tool determines which land use types are allowed to be allocated into each base geometry polygon based on the general plan codes and settings. The fourth tool calculates the constraints on the base geometry polygons. The fifth tool calculates the net attraction for each base geometry polygon.

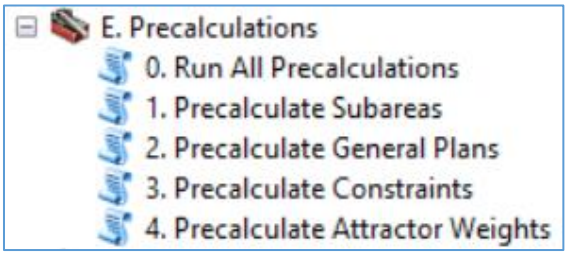

Figure 4.32 – Precalculations Toolbox

4.6.0 Run All Pre-Calculations

This tool runs all of the calculations UPlan requires before performing allocation. It assigns all base geometry polygons: (1) a SubArea; (2) a General Plan category and permissions for each land use; (3) a constraint value; and (4) a net attraction value. More detailed explanations of these 4 steps are outlined in the next 4 sections of this manual. If this tool is run, none of the other tools in this toolset need to be ran because they perform these 4 steps individually.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Save Disaggregate Weights is an optional feature. If you put a checkmark in this box, a table will be created that reports the attraction weight for each base geometry polygon by time step, land use code, and attraction layer. If you check this box the tool will take a long time to run, please be patient. For my test UPGDB, this option incnreases the runtime from 5 minutes to 1 hour and 10 minutes.

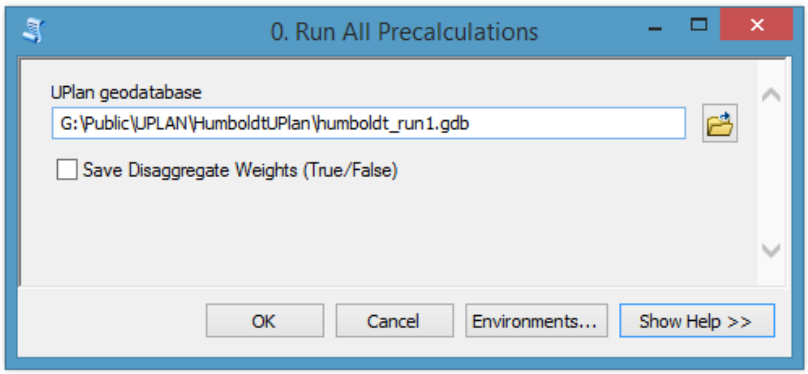

Figure 4.33 – Tool to Run All Pre-Calculations

When this tool has finished running the up_sa, up_bg_gp_<TSCode>, up_bg_gp_avail_<TSCode>, up_const, up_constraints_<TSCode>, up_disagg_const_<TSCode>, up_distances and up_net_weights tables will be updated. If you checked the Save Disaggregate Weights box, the up_disagg_weights table will be updated. TSCode = Time Step Code

4.6.1 Pre-Calculate SubAreas

This tool assigns all base geometry polygons to a SubArea. If the centroid of the base geometry polygon is located within a SubArea, that SubArea will be assigned to the base geometry polygon. If the centroid of the base geometry polygon is located outside of a SubArea, it will be assigned to a SubArea if it is within the maximum distance parameter set in the Import SubArea Layer tool (section 4.2.6), otherwise it won't be assigned a SubArea and therefore won't receive any future growth.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.

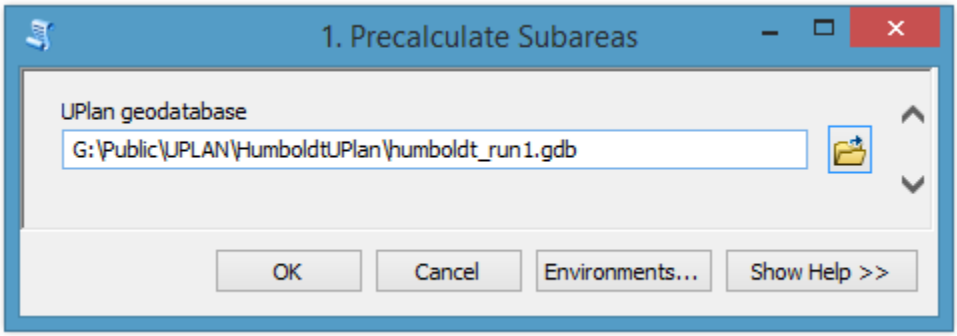

Figure 4.34 – Tool to assign SubAreas to Base Geometry Polygons

When this tool has finished running, the up_sa table will be updated.

4.6.2 Pre-Calculate General Plans

This tool assigns General Plan categories to base geometry polygons using the centroid of the base geometry polygon. It then determines which land use classes are allowed to be allocated into each base geometry polygon based on the parameters set up in the Set General Plan Settings tool (section 4.4.6).

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.

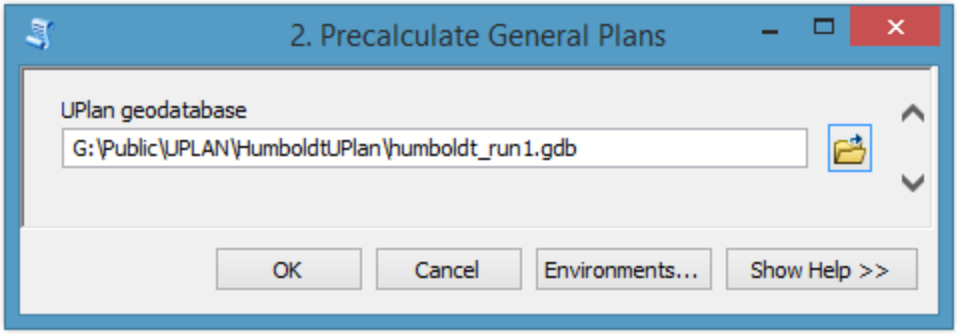

Figure 4.35 – Tool to assign General Plan Codes to Base Geometry Polygons

When this tool has finished running, up_bg_gp_<TSCode> point shapefile(s) will be created to store the general plan code for each base geometry centroid and the up_bg_gp_avail_<TSCode> table(s) will be updated. TSCode = Time Step Code

4.6.3 Pre-Calculate Constraints

This tool calculates the developable acres for each base geometry polygon. It begins by calculating the acreage of the base geometry polygon. It then determines if any constraint layers overlap with the base geometry polygon, if so it uses the constraint weight from the Set Constraint Weights tool (section 4.4.4) to reduce the developable acreage where they overlap. If more than one constraint layer overlaps at the same location, the sum of constraint weights are used. For example, if constraint layer 1 has a weight of 50% and it overlaps with constraint layer 2 that has a weight of 30%, then the combined constraint weight would be 80% and the developable acres would be 20% of that locations acerage.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.

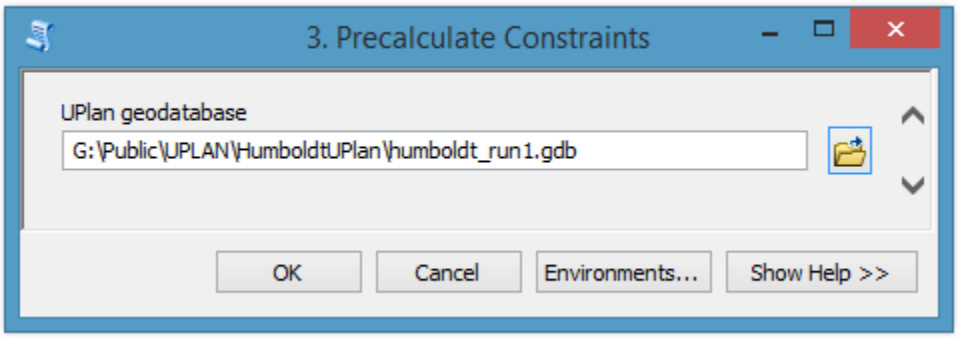

Figure 4.36 – Tool to Calculate the Developable Acres of Base Geometry Polygons

After this tool has finished running, the up_const, up_constraints_<TSCode>, and up_disagg_const_<TSCode> tables will be updated. TSCode = Time Step Code

4.6.4 Pre-Calculate Attractor Weights

This tool calculates the net attraction value for each base geometry polygon. It begins by calculating the distance from the base geometry polygon to every attraction layer. By land use type and time step, it then uses the weights set in the Set Attractor Weights tool (section 4.4.2) to determine the attraction value at that base geometry polygon from each attraction layer. It then sums up all of the attraction values from all of the attraction layers, and their associated weights, to assign the base geometry polygon a net attraction value. This value will be used to prioritize allocation of future growth if the allocation mode was set to Normal in the Add Land Use tool (section 4.3.3).

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.

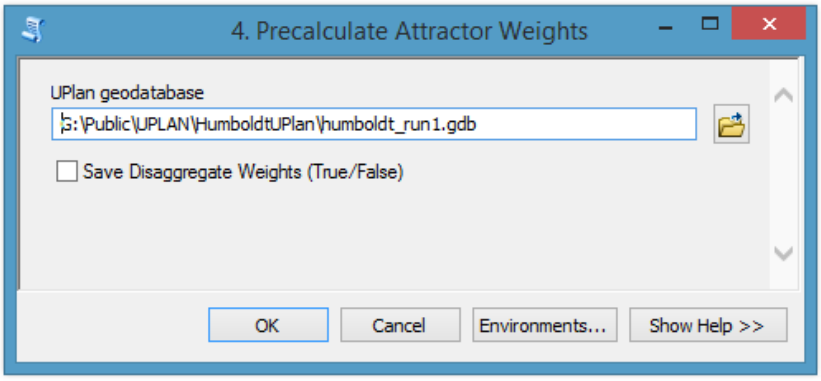

Figure 4.37 – Tool to Calculate the Net Attraction Value of Base Geometry Polygons

After this tool has finished running, the up_distances and up_net_weights tables will be updated.

4.7 UPlan Run Toolset

This toolset contains the tool to run allocation. It should be ran after the Run Land Use Demand tool (section 4.5.7) has been run, and all of the precalculations have run in the Precalculations Toolset (section 4.6). It will use all of the UPlan settings from the previous toolsets to try and allocate the future growth, if it is unable to allocate all households or employees it will report this back to the user.

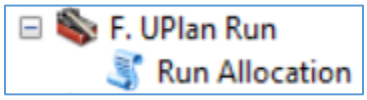

Figure 4.38 – UPlan Run Toolbox

4.7.1 Run Allocation

This tool allocates future households and employees to base geometry polygons. It uses the layers, settings and calculations performed by Toolboxes A-E to determine the location and amount of acres that need to be allocated. The methods for allocating future growth are outlined in section 3.1.9 of this manual.

It will output tables that contain the acres allocated, by land use type, to each Base Geometry polygon. There are tables that report the acres allocated during each time step (upo_ts_alloc_<TSCode>) and the cumulative acres allocated at the end of each time step (upo_cum_alloc_<TSCode>,). If the model is unable to allocate all of the acres demanded, these underallocated acres are reported in a third table for each time step (upo_und_alloc_<TSCode>).

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.

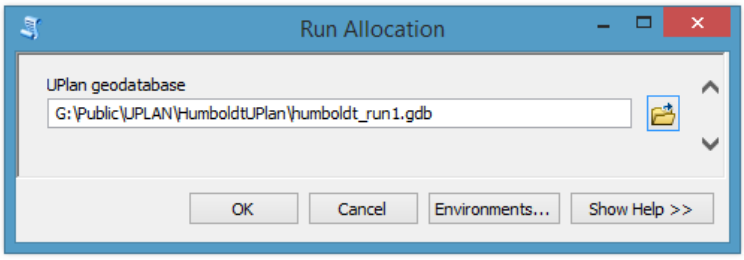

Figure 4.39 – Tool to Allocate Future Growth to Base Geometry Polygons

When this tool has finished running, the upo_cum_alloc_<TSCode>, upo_ts_alloc_<TSCode>, and upo_und_alloc_<TSCode> tables will be created or updated. TSCode = Time Step Code

4.7.2 Display Allocation

After running allocation, the upo_* tables have been added to your UPGDB. To display these results on a map you need to open ArcMap. Once ArcMap is open, add the Base Geometry polygon layer and any of the upo_cum_alloc_* tables you would like to display. Join the cumulative allocation table to the Base Geometry layer based in the Base Geometry ID field (if you have forgotten what this field is, look in the up_key table). You can now symbolize the Base Geometry ID based on the LUDesc field.

Display Allocation Steps:

1. Open ArcMap
2. Add your Base Geometry polygon layer
3. Add your Cumulative Allocation table
    a. upo_cum_alloc_<TSCode>
4. Join the Allocation table to the Base Geometry layer based on the Base Geometry ID field
    a. R-Click on the Base Geometry layer
    b. Select: Joins and Relates > Join…
    c. In the second box, select the cumulative allocation table if it isn't already selected for you
    d. In the first box, select the Base Geometry ID field
    e. If the third box doesn't populate automatically, select the same Base Geometry ID field
    f. Click OK to the Join Data window
5. Symbolize the Base Geometry layer with the land use it was allocated
    a. R-Click on the Base Geometry layer
    b. Select: Properties…
    c. Click on the Symbology tab
    d. In the left panel, select Categories > Unique Values
    e. Set Value Field = LUDesc
    f. Click on: Add All Values
    g. Select Colors for the different land use types
        i. If you are using a Base Geometry layer with small polygons, turn off the boundary color or set the width equal to 0
        ii. Uncheck the box next to <all other values>
        iii. Set the fill color of the blank value equal to No Color
    h. Click OK to the Layer Properties window

4.8 Analysis Toolset

This toolset contains the tools to summarize future growth by zones. It is an optional tool and can be run after the Run Allocation tool (section 4.7.1) has completed. For each time step, it will summarize the number of people, number of households, and number of employees by Zone along with the amount of acres they consume.

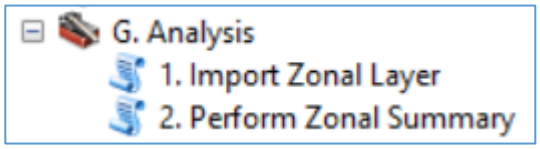

Figure 4.40 – Analysis Toolbox

4.8.1 Import Zonal Layer

This tool is used to add a zonal layer to the UPGDB. This can be any zonal layer. For example, Transportation Analysis Zones (TAZs) can be used to inform a transportation demand model. The layer must include a field that has a unique ID for each zone.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Input the zonal layer into the second box by either dragging it from ArcCatalog or using the folder button to the right of the box.
3. In the third box, type in a descriptive name for the zonal layer you inputted in the second box. This name may contain spaces.

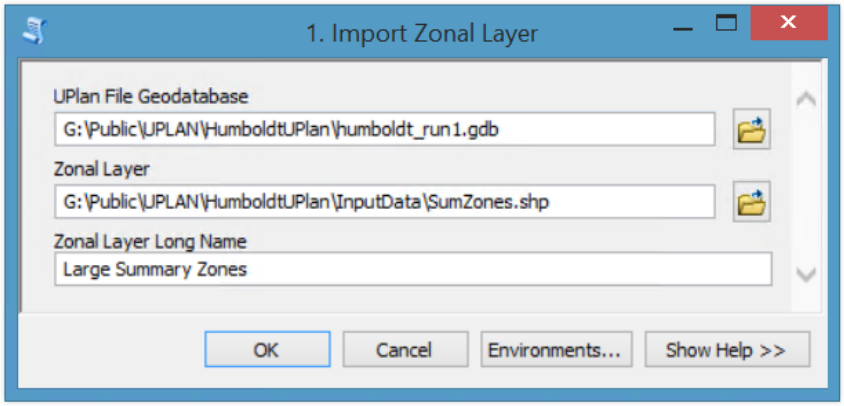

Figure 4.41 – Tool to Import a Zonal Layer

When this tool has finished running, the constraint layer will be added to your UPGDB and a row will be added to the upc_layers table.

4.8.2 Perform Zonal Summary

This tool is used to summarize the number of people, number of households, and number of employees by Zone along with the amount of acres they consume. The user can do this for all time steps or choose just one. They may also choose to report what was allocated during that time step, what was allocated during that and all previous time steps, or both. A table will be created for each option the user chooses.

Tool steps:

1. Input the UPlan Geodatabase. Input the directory path into the top box of the tool by either dragging it from ArcCatalog or using the folder button to the right of the box.
2. Select a time step that you would like to summarize or choose 'All Timesteps' to create summaries for all time steps.
3. Select the type of summary you'd like to create
    a. Timestep Allocation Only – Only the acres allocated during the time step or time steps selected above will be reported.
    b. Cumulative Allocation – Only the cumulative acres allocated at the end of the time step or time steps selected above will be reported.
    c. Both Timestep and Cumulative Allocation – The acres allocated during and the acres allocated at the end of the time step or time steps selected above will be reported.
4. Select the layer with the zones you want to summarize by. If you don't see the layer you want, add it using the previous tool – Import Zonal Layer (section 4.8.1).
5. Choose the field within the layer selected above that contains unique IDs for each zone.
6. Type in the maximum distance allowed between a Base Geometry centroid and the extent of the Zonal layer in order for that Base Geometry feature to be assigned to a Zone.

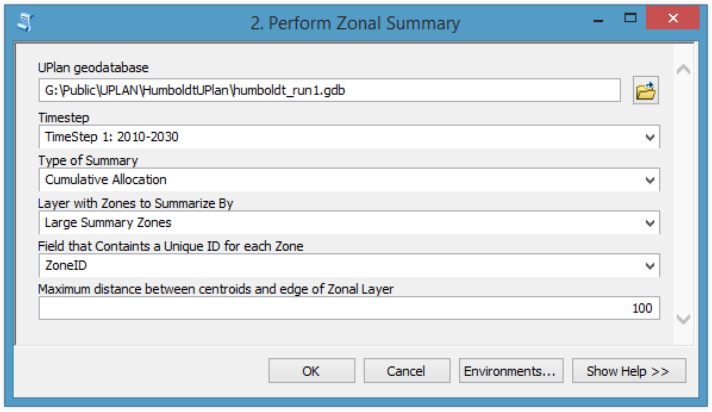

Figure 4.42 – Tool to Summarize Allocation by Zones in a Zonal Layer

When this tool has finished running, a table will be created that links Base Geometry IDs to the zonal layer's ID (upa_ZoneXWalk), and depending on the type of summary you requested summary tables will be created for cumulative allocation (upa_sum_cum_alloc_<TSCode>) and/or time step allocation (upa_sum_ts_alloc_<TSCode>). TSCode = Time Step Code. If your summary tables contain a row that does not have a Zonal ID, then one or more of the Base Geometry centroids fell outside of the zonal dataset (look at the FREQUENCY field to see how many). Edit your zonal layer extent so that it covers all Base Geometry centroids to fix this problem.

5 - FAQs

1. I want to edit/update a constraint or attraction layer without re-uploading it to the UPGDB because I don't want to input all of the buffer and/or weight values again, is this possible?
    a. If you are very careful this is possible. As long as the name of the attraction or constraint layer doesn't change, you won't run into an error. So, remove/delete the old attraction or constraint layer from the UPGDB and then add the updated layer to the UPGDB with the exact same name. Then run either the Pre-Calculate Constraints or Pre-Calculate Attractor Weights tool depending on the type of layer you edited/updated.
2. I want to edit/update the tables in the UPGDB outside of the UPlan4 toolbox (either manually editing or editing with a script), is this possible?
    a. Once again, if you are very careful this is possible. Go ahead and edit the tables, but before you use any tools within the UPlan4 Toolbox open the Uplan4Shortcuts python toolbox and run the Update UPlan GDB after Manual Edit tool. This will update the python pickle (text) file in the UPGDB that stores all of the UPlan settings. Now feel free to use any of the tools within the UPlan4 toolbox.