FINAL

Sustainable Places Analytical Resources Core (SPARC):

A Common Data Schema for Scenario Planning

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Prepared for the

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by

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Contents

Document Changes from Draft to Final

Document graphics re-inserted as bitmaps throughout.

Revised the diagram on page 6 showing the relationship between SPARC, DQIS and the other components in the Sustainable Places Project.

The Hardware Requirements section has been revised to accommodate the persistent (rather than temporary) storage of uploaded shapefiles inside the GISIO SPARC database model.

The Ancillary Zip File Layer Attachment function-- where a GIS Steward may optionally attach one additional zip file with any layer upload-- is described on page 14.

New fields in the sp_planninglayer model due to the zip file attachment feature are reflected throughout the Model Descriptions section and described on page 21.

Support for a greater level of accuracy on only the "3D Feature Footprints " PGLT class described in the "Reduce" section on page 12.

The list of available Primary Geometry Layer Types (PGLTs) is finalized in Appendix A.

The list of initial PGLT Field Definitions (FieldDefs) is finalized in Appendix B.

Section on proposed enhancement Hierarchical Aggregation Model moved to DQIS specification's Roadmap section.

References to the Data Quality Wizard (DQW) changed to the Data Quality and Interoperability Service (DQIS) throughout.

Introduction

Sustainable Places Project Requirements

The Capital Area Texas Sustainability (CATS) consortium, in fulfilling the requirements of its Sustainable Places Project, has requested scenario planning components from a number of different sources. Examples of the tools being developed include:

- A suite of tools (apps) for an upcoming version of Envision Tomorrow called ET+ developed by Fregonese Associates.
- Fiscal impact and Return On Investment (ROI) models, developed in conjunction with the University of Texas, customized to the areas where they are being applied.
- Integrated land-use and transportation modeling tools developed in conjunction with CAMPO.
- A public-engagement GIS web portal for reporting scenario planning results and facilitating stakeholder involvement, being developed in conjunction with the Texas Advanced Computing Center (TACC).

Though each of these tools is unique, there is significant overlap in terms of their GIS inputs and outputs. Additionally, there will be a requirement to integrate the tool results into a single normalized form for scenario ranking and results publication.

In regards integration, the CATS consortium faces a challenge that is a microcosm of a general trend in scenario planning: interoperability between tools is limited and therefore a time-consuming, expensive workflow. For more information on the state of scenario planning and the tools which support its processes, refer to the Lincoln Institute's Policy Focus Report "Open Access to Scenario Planning Tools" (Report Code PF031, http://www.lincolninst.edu).

The Sustainable Places Project is being funded through a HUD Sustainable Communities grant, which requires open access to developed tool components. With a new wave of tool components being created through this and other HUD grants, the CATS consortium recognizes the benefit of creating an open platform for data exchange, facilitating the generation of synergy between diverse tool ecosystems.

This document details a client-server database schema that can support the exchange of GIS data between a wide variety of scenario planning tools.

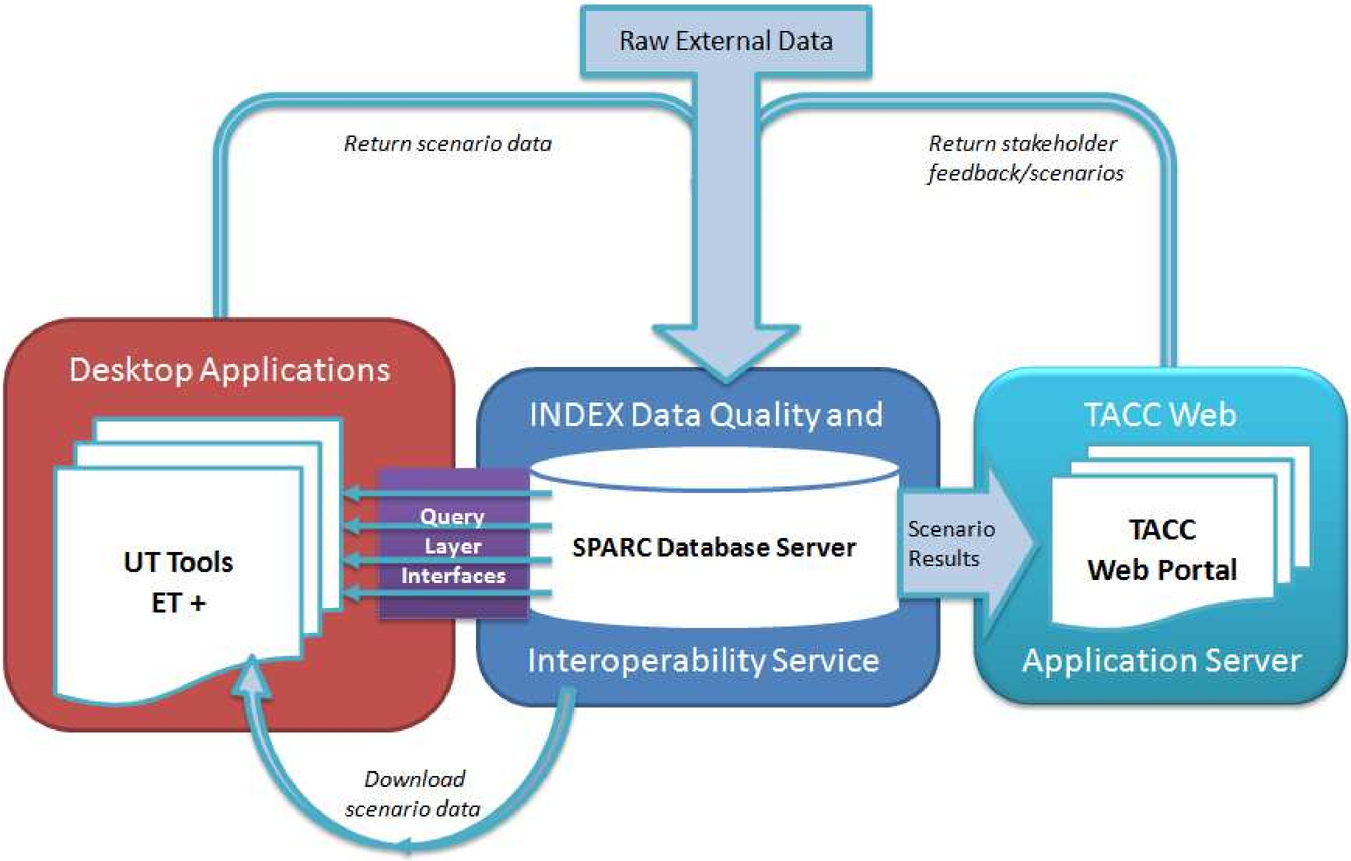
The Sustainable Places Analytical Resources Core (SPARC)

The purpose of SPARC-- and the INDEX Data Quality and Interoperability Service (DQIS) which serves as its gateway-- is to provide a managed way of importing GIS data, running it through a series of quality tests and cleanup processes tailored to scenario planning requirements, and storing this higher-quality data in an efficient, normalized form for consumption by other client applications.

Use cases for a SPARC data warehouse implementation can be understood from both the CATS Sustainable Places Project's perspective, as well as a generalized one:

Sustainable Places Project specific use case	Equivalent generalized use case
The GIS stewards at Diva Imaging employ the DQIS interface to upload raw external GIS data into SPARC. These data sets are then downloaded by Fregonese for analysis in ET+.	A GIS steward employs the DQIS interface to convert raw external GIS data into normalized scenario planning GIS data sets in SPARC. These data sets are then downloaded by a tool user for tool-specific scenario-creation / analysis.
Fregonese employs the DQIS interface to upload GIS data layers resulting from analysis to SPARC. CAMPO and UT staff download this data to import into their respective models for further analysis.	A tool user employs the DQIS interface to upload GIS data layer to SPARC. Other tool users download this data to import into their respective models for further analysis.
TACC's web portal accesses SPARC through an application server and publishes results in a form viewable by stakeholders using a simple web browser.	Compliant web application servers access SPARC warehouse data for presentation purposes.

The following diagram shows these use cases as they apply to the Sustainable Places Project:



The following principles drive the development of this schema (and its acronym):

- **SP** for "Sustainable Places" (but also "Scenario Planning"): The schema is being developed for the Sustainable Places Project and its highest priority is fulfilling the requirements of this project. The schema, however, can also be of value to the scenario planning community at large.
- **A** for "Analytical": scenario planning has been on the forefront of pushing GIS from its roots in map production into the realm of spatial analysis. The value-add of any scenario planning tool is its ability to inform a planning process by providing objective numerical analyses of target areas in the form of indicators. The schema must be supportive of a tool's ability to produce and display indicators.
- **R** for "Resources": In the short term, the Sustainable Places Project is concerned with ensuring the interoperability of the project's constituent scenario planning tools. Designing the schema to be extensible positions the Sustainable Places Project to grow and evolve with existing and emerging scenario planning resources.
- **C** for "Core": While it performs a number of GIS operations valuable to scenario planning, SPARC is not itself a scenario planning tool. Rather it is a central clearinghouse which other applications can rely on for the exchange of consistent, predictable data. Having access to normalized, quality-controlled GIS data allows scenario planning tool developers to focus on what's important (see "A" above).

While the Sustainable Places Project will fund the first implementation of SPARC, other organizations are free to adopt the schema and grow the core functionality.

SPARC as a Meta-schema

Does scenario planning have a modeling problem? Well, it depends.

Consider the challenges presented by the following scenario planning use case, familiar to any experienced modeler:

A scenario planning exercise requires a land-use layer, i.e. a table of polygonal land-use geometries and, associated with each geometry feature, a collection of feature attributes. One would want to hard-code the existence of a land-use object into any scenario planning schema, but there is a wide variance in the kinds of attribute data objects (columns) that may be associated with any land-use layer. Does it have population? Dwelling units? Both? What about employment? Job counts? Commercial square footage? What about Retail square footage AND Office square footage?

Answers to the above questions almost always begin with "well, it depends":

- It depends on what you use for your land-use. Different sources of GIS data-- each with their own attribute sets-- are frequently employed for the same purpose in scenario planning. A land-use layer could be comprised of parcels, grid cells, TAZs, planned land-use or even census blocks. No two GIS datasets share the same set of attributes.
- It depends on where you are focusing your analysis. Availability of attribute data differs from area to area, sometimes even within the same jurisdiction.
- It depends on which indicators were run. A single tool can produce dozens of indicator score attributes for a given land-use polygon.
- It depends on which tool you want to run. Tools require different attributes to perform their analyses.
- It depends on which version of the tool you're using. As tools evolve so too do their data requirements. New indicators (output attributes) are being developed all the time, often in reaction to the emergence of new data sources (input attributes).

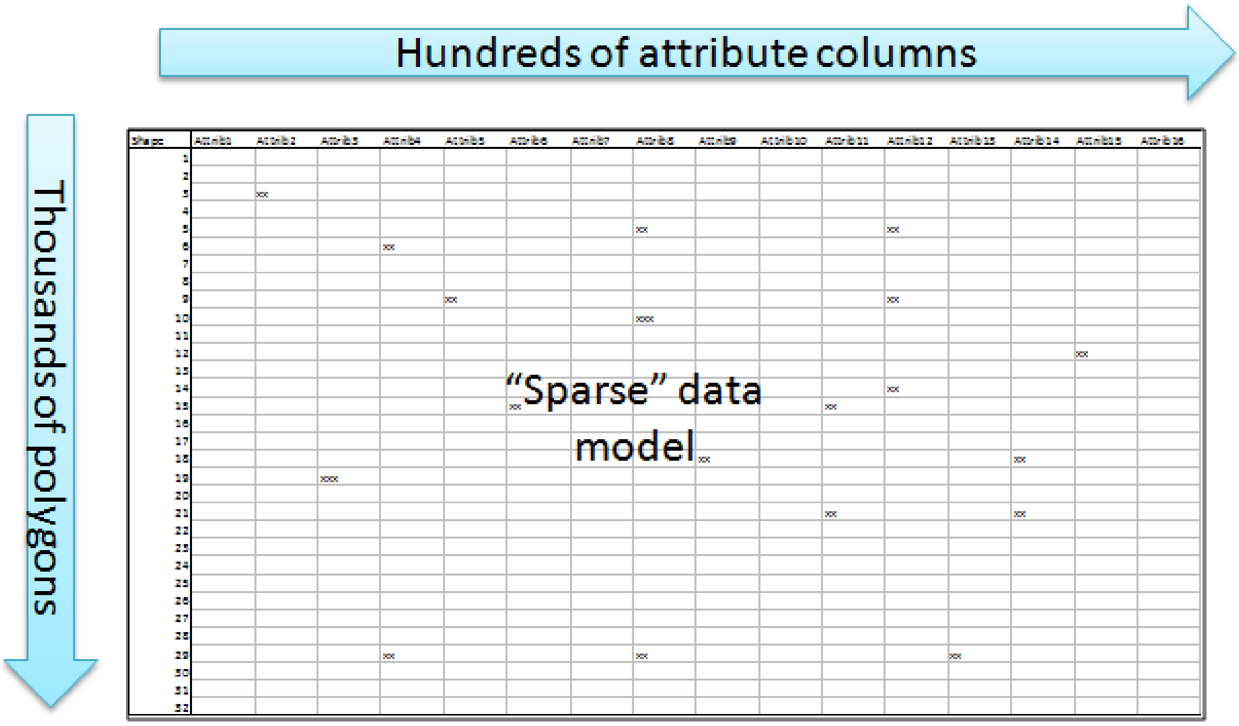
When one considers both raw existing conditions data as well as attributes resulting from analysis (indicator scores), the list of possible attributes quickly goes into the hundreds-- with more to come in the future as new indicators are developed. And this wide attribute variance extends beyond land-use to many other layer types required for scenario planning.

The Traditional Flat-file Schema

Traditional schemas feature a defined/limited set of objects that may be used to store data. When the requirements for a schema are both well-defined AND unlikely to change in the future, this approach is ideal because such rigid structures are inexpensive to deploy. However there is no room for a new data object that does not already have a place in the schema.

Within the traditional schema design approach, one would model the wide attribute variance problem by creating a land-use class object containing all possible land-use attributes, including not only raw data inputs but also indicator analysis results calculated for the land-use. Such a table would end up with hundreds of columns, many of which would be left blank for a given layer/polygon.

The end result is an inefficient, space-consuming "sparse" data model:



Beyond these adverse performance effects, when a new data object requirement inevitably arises-- as a result of newly available external data and/or new indicator algorithms-- there is no place for it, so the schema is re-written, and a new column added, making the old schema obsolete.

The SPARC Approach: A Meta-schema

"Meta" schemas are those which do not hard-code data objects, but rather provide a re-useable, expandable set of objects through which a user may customize the definition of the objects they intend to use. Such models offer the greatest amount of flexibility, but it should be noted come at a cost of increased application overhead (to create the management interface for defining meta-objects), as well as a certain reduction in database optimization.

SPARC balances overhead costs and performance hits while supporting wide attribute variance and the likelihood of future schema changes by implementing a partial "meta" model:

- All possible scenario planning SPARC Primary Geometry Layer Types (PGLT, e.g. land-use, street centerlines) are hard-coded as inheritable parent objects, and contain only the fields that scenario planning processes require in almost all cases (e.g. polygon shape field, land-use classification, street functional class).

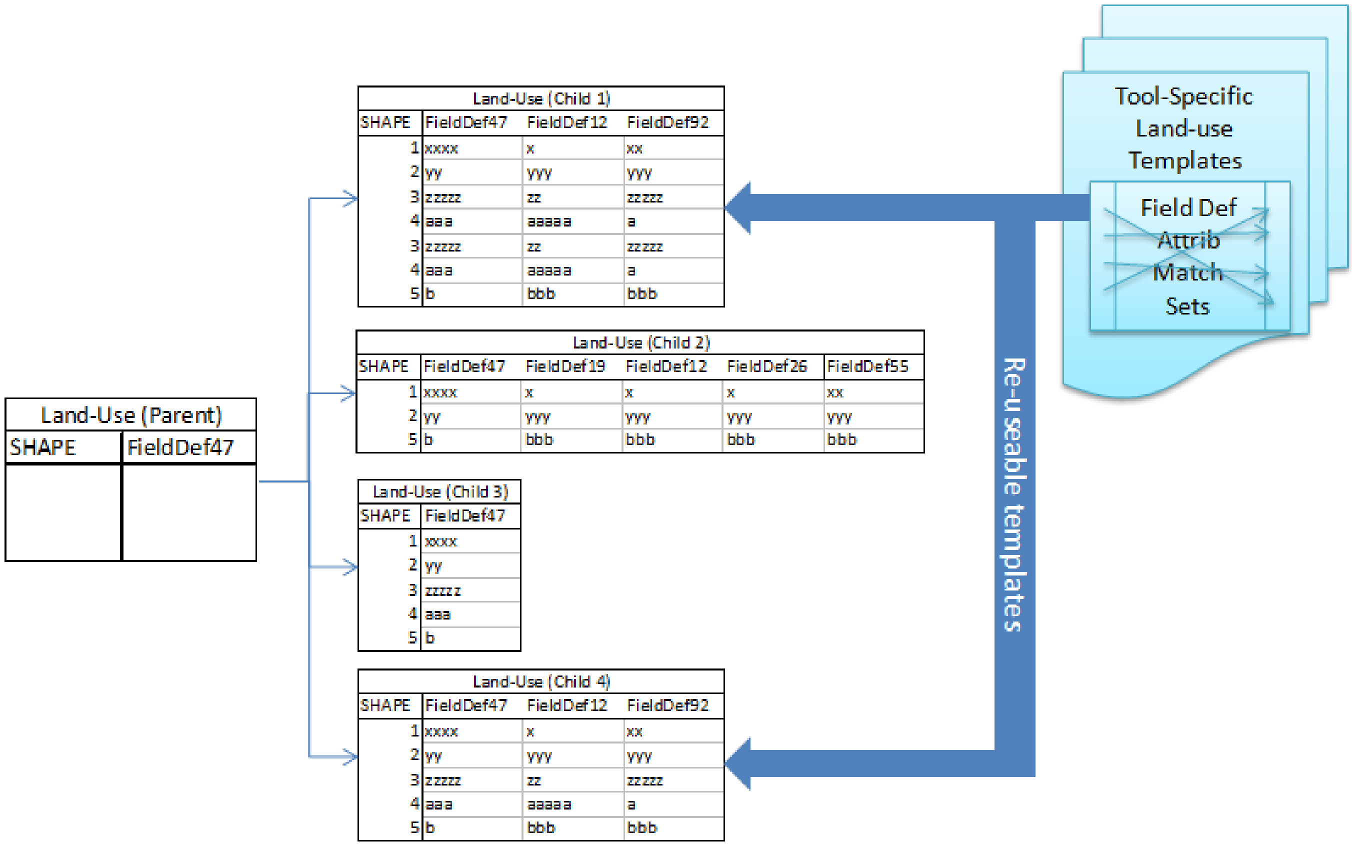
  See Appendix A for a complete list of proposed PGLTs

- When an external GIS data layer is to be imported, a new instance of the parent table object is inherited.
- The user associates each desired external data attribute with a SPARC Field Definition (FieldDef) chosen from a list.

  See Appendix B for a list of all FieldDefs supplied in a default SPARC implementation.

- The child table's field set is expanded programmatically to hold the selected incoming attributes. The properties of these dynamically-created fields come from the FieldDef object associated with each attribute.

The following diagram illustrates dynamic table inheritance:



An important benefit of table inheritance is the ability to perform database queries on the parent table. This is the mechanism through which SPARC users could perform cross-scenario analysis.

Field Definition Objects Ensure "A is A"

SPARC's flexibility supports the Sustainable Places Project's current requirements, as well as positioning it to leverage other tools and emerging planning layers, whose attributes have yet to be defined. But there is a risk in any flexible, permissive schema that the relationship between identical objects can become lost.

Consider the example where one user uploads a street centerlines layer covering an activity center that contains an attribute called "FuncClass". Later, another user uploads a different street centerlines layer for a second activity center containing an attribute called "FC". In scenario planning, it is crucial to know if these two attributes are in fact reporting the same thing or not, especially if there are analytics which require this attribute to execute.

SPARC FieldDefs assure attribute identity across the unreliable variety of incoming attribute names. Requiring users to select a "destination" FieldDef for each of their incoming layer's "source" attributes provides a high level of certainty to consuming applications about the contents of any SPARC layer.

See Appendix B for a list of all FieldDefs supplied in a default SPARC implementation.

If the incoming data layer contains an attribute with no matching SPARC FieldDef, new field definitions can be created and saved using a DQIS content management interface. With hundreds of possible FieldDefs, the system must guard against users re-creating duplicate FieldDefs, as doing so would undermine the model's function. Therefore this content management interface may be restricted, or search functions or other checks may become part of the DQIS specification.

Tool Adoption and Interoperability Through SPARC Template Engine

SPARC is flexible enough to support the uploading of any scenario planning GIS layer. However, a given SPARC implementation will feature only a limited set of uses by a known set of scenario planning tools, which themselves only feature a certain set of data inputs/outputs.

To help narrow workflow to these uses, SPARC contains objects allowing for the particulars of an external data upload process to be saved for later re-use on another similarly-structured external data layer. The Data Quality Wizard specification contains a proposal to save/re-use such objects as:

- The properties of the incoming layer itself
- The set of FieldDefs appended to the inherited target PGLT
- The external data layer attribute names mapped to each FieldDef.

Upon selection of a template, the incoming data source is scoured and much of the import matching process can occur automatically. If adjustments are made, the new upload definition can itself be saved as a template for later re-use.

There are obvious advantages to data upload process templating:

- Faster workflow
- Less risk of operator error in choosing the incorrect Attribute-FieldDef match

Beyond the obvious workflow advantages, this templating system is also where a generic SPARC implementation gets "branded". Through template customization and organization, a scenario planning tool in effect publishes its data objects to all SPARC users. In this way, the SPARC template engine functions as a scenario planning tool workflow documentation engine.

Finally, when 2 different tool providers publish their data objects as templates in SPARC, they do so using the same interoperable taxonomy: what manifests is a basis for mapping a conversion of one tool's data set to the other, drastically reducing the effort required to move back and forth between models.

For the Sustainable Places Project, SPARC will come pre-loaded with whatever tool templates are supplied prior to its initial implementation. Others can be added by tool providers after the system goes live.

A "Sustainable" Geometry Model

Reduce

Scenario planning GIS activities operate within a particular geographic range, from an entire state or two at most, down to a single building footprint. The more precision used in the storage of geometries in a schema, the more disk space is required and the more resource intensive any analysis operation (e.g. intersection) is. Many raw GIS data sets that are of interest to scenario planning carry a level of precision that is of no functional use.

SPARC simplifies all PGLT geometries it stores (with one exception, see below) down to the ***nearest meter***, a precision that still exceeds scenario planning requirements. Doing so significantly reduces the overhead required to perform indicator calculations, the speed of which is of crucial importance to scenario planning.

The one exception to the "nearest meter" simplification process is the 3D Feature Footprints PGLT. Geometries stored in tables inherited from this PGLT will be simplified down to the nearest 0.1 meters, in order to support an even greater level of accuracy for data that is being transferred between users involved in desktop 3D visualization.

Re-use, Recycle (and Relate)

Another key challenge facing scenario planning GIS is the fact that the same geometries are used again and again. The most obvious example is that between two scenarios, usually most if not all of a layer's geometry remains the same, even while many of the attributes are "painted" to have a different set of attributes.

In traditional scenario planning databases, layers of mostly identical geometries are loaded and copied over and over again with each new scenario (or other use). Because line and polygon geometries are large data types, GIS databases quickly become bloated in size, difficult to backup and expensive to maintain. Performance-wise, analysis and reporting queries run slower the larger database objects become.

Another negative side-effect of this proliferating layer approach to data modeling is of particular importance to scenario planning: when a geometry is replicated across layers, there is no explicit relationship joining identical geometries to each other. When two identical geometries (for example, the same parcel in two different scenarios) are not explicitly related to one another, there is no efficient way to perform inter-scenario comparisons-- and detailed scenario-to-scenario comparison is one of the key workflows in scenario planning.

SPARC addresses this issue by separating the storage of geometries from the storage of a layer's feature attributes. Database functions and triggers support this separation:

- Each unique geometry is stored only once in a master polygon, line or point feature class.
- Layer features/attributes are stored as rows in a child table inherited from a Layer Type parent (see previous section). Layer feature child tables always have a field called "GeomID" that indicates which geometry in the master geometry class is the geometry associated with the feature.
- During the layer import process, incoming geometries are checked using an efficient comparison mechanism with the set of geometries already stored in the geometry table. If the incoming geometry does not yet exist, it is stored; if it does exist, the geometry is discarded and the GeomID of the existing geometry is used instead.
- Every new layer import generates a unique "query layer" object that presents a traditional flat-file view of the layer, one that client applications (and users) would expect. These views-- and not the efficient multi-table storage model-- are what is published by SPARC for consumption by users.

In combining the strategies of reduced geometry sizes and separate/unique geometry storage, SPARC will support faster analysis, be less expensive to maintain and easier to scale.

Store and Serve Planning Geometries

SPARC's mandate is to support scenario planning. Therefore all geometries are to be served natively with standard planning-specific spatial information available as attributes:

- segment length in feet and meters for lines (for polygons, length of perimeter)
- area in sqft, acres, sqmi
- area in sqm, hectares, sqkm
- interior centroid x/y coords
- geometry vertex count, min/max x/y extent coordinates

The GIS projection for all SPARC geometric data is to be EPSG 3857 (ESRI WKID 102100 Web Mercator Auxiliary Sphere):

- Unified projection speeds up rendering significantly
- Coordinates range from +/- 20,037,508 (meters from poles)
- Seamless integration with Google, OpenStreetMap (http://wiki.openstreetmap.org/wiki/EPSG:3857)
- Seamless integration with ESRI's WMS standard for ArcGIS Online:
    - http://help.arcgis.com/en/arcgisonline/content/index.html#//011q00000012000000

Other Assumptions/Objectives

While flexibility is desirable in any implementation, system performance-- put another way, saving money on the cost of adding new hardware resources-- is also a key factor. Several right-sizing design choices were made in SPARC based on the assumptions detailed in this section.

SPARC Hardware/Software Specifications

Cutting edge server hardware is required due to the extreme demands of serving GIS data. SPARC is designed with the assumption of being implemented on a dedicated server with the following minimum recommended server specifications:

- 64 bit Quad-core CPUs
- 16 GB RAM
- Dual 256 GB SSD (or equivalent high-speed) hard drives configured in RAID 0 (striped)

A Linux operating system is required. Recommended options include:

- Ubuntu 11.10 or higher
- Centos 6.2 or higher

The GIS DB software stack specifications:

- PostgreSQL 9.1 with pl/pgsql installed
- PostGIS spatial extension 1.5 or higher
- GEOS 3.3.3
- PROJ 4.7
- GDAL/OGR 1.8

Support for Ancillary Zip File Layer Attachments

SPARC is intended to store scenario planning GIS data rather than be a generic model for the exchange of just any data file. Beyond the GIS and attribute data contained in an uploaded shapefile, however, there are potentially numerous other data files-- specific to scenario planning and related to a given layer-- which a GIS Steward might want to "attach" to the shapefile being uploaded to SPARC, and have available for download by another user.

SPARC layers contain fields that can optionally save a pointer and description of a file attached in this way to a shapefile at the time of its initial upload. Though only one file is supported, this file could be a zip/tar file that contains many files.

See the DQIS specification for more information on use cases.

SPARC Users are not Architects

Architecture and Planning often intersect professionally, but there are limitations in SPARC that may preclude actual architectural uses:

- Architectural geometries would require a greater degree of precision than the nearest square meter.
- Building Floors are not supported at this time.

Primary Geometry Layer Type (PGLT) List is Fixed

See Appendix A for a complete list of proposed PGLTs

There are innumerable engineering GIS uses, but the following reasons explain why they may not want to adopt SPARC for their modeling purposes:

- The PGLT list is fixed in SPARC and limited to the set of unique geometry layers which both describe an aspect of the built or natural environment AND are deemed useful to scenario planning analysis (i.e. indicator calculation).
- The palette of all possible engineering PGLTs is much more diverse. So, for example, utility poles, sewer main lines, and other infrastructure layers are not supported as SPARC PGLTs.

Of course, any GIS feature at all can be included in a SPARC scenario as a derived "effective area" or "feature buffer" polygon added to the Policy Focus Area (PFA) layer type.

Also, every Layer Group has a miscellaneous inheritable class so that exceptional layers can make it into SPARC.

SPARC is Not a Transportation Model

The line separating transportation engineering from planning is often difficult to distinguish. It was determined that the requirements of supporting 4-step or other transportation models directly in SPARC were out of scope, with the following caveat:

- Insofar as transportation modeling GIS requirements can be expressed using the SPARC Template Engine and fulfilled from an external GIS source, transportation engineers are encouraged to publish their GIS layer requirements in SPARC.
- Example: A SPARC TAZ layer type containing Pop and Emp for a horizon year can be used as an input to TransCAD

All SPARC Implementations Contain a Built-in Geographic Limit

There must be a top level to any SPARC implementation, referred to as the Maximum Geographic Boundary. The MGB defines the client's maximum possible geographic limit of analysis. This limit may be quite large (perhaps several counties or multiple states) but it must be defined up front before the implementation occurs. All incoming GIS datasets are trimmed to the MGB.

The size of the MGB becomes tied to the hosting fees charged by cloud server providers. Reducing the size of the MGB saves a client from paying for needless hardware capacity.

An MGB cannot be altered without rebuilding the SPARC implementation.

The Federal government, the magnitude of whose national data sets would require an entirely different model, are therefore not intended to use SPARC as a primary management system for their data. As with transportation engineering, the following caveat applies:

- Insofar as a federal agency's GIS requirements can be expressed using the SPARC Template Engine and fulfilled from an external GIS source, federal agencies are encouraged to publish their GIS layer requirements in SPARC.
- Example: the EPA's Smart Location Database (SLD) is managed at a Census Block Group level. If the SLD schema was published in the SPARC template engine, SPARC tool providers engaged in a local jurisdiction could gather more accurate local data attributes and upload them using the SLD SPARC template.

Data Vintage a Property of a Field Definition Instance, Not the Field Definition Itself

When a SPARC layer instance is being created to hold incoming data, the user selects FieldDefs matching the incoming external data attributes. When selecting a FieldDef, the user must also supply a year or vintage that the data in the attribute applies to.

SPARC is not meant to contain FieldDefs for, say, Pop2010, Pop2015, Pop2020, etc; rather, there is one FieldDef, Pop, and the vintage of this Pop attribute can be derived by inspecting the data_year property of the Layer's FieldDef instance.

In traditional flat-file models, creating a new layer meant duplicating all the geometries and losing the relationship between identical geometries in different layers. SPARC's sustainable geometry model ensures that even if layers are split up by year, there is no duplication of actual geometries, and the relationship between layer geometries can be easily navigated.

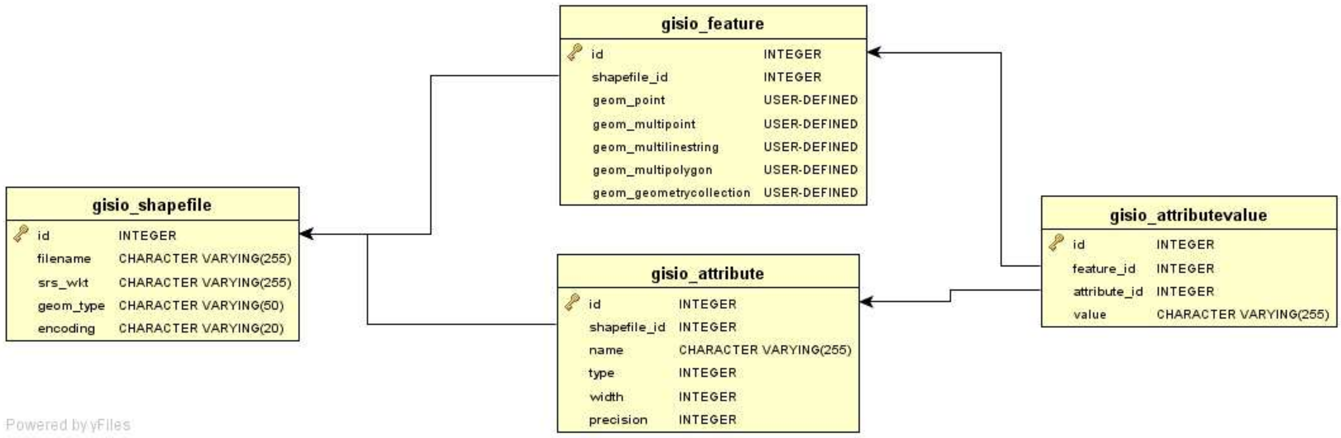
Existence of a Schema Object Not a Guarantee of Implementation in DQIS

The Data Quality and Interoperability Service (DQIS) application is the tool through which a user uploads and downloads data from SPARC. Note that not all database schema objects in the SPARC specification are fully implemented in this first version of DQIS. See the DQIS specification document for a complete list of DQIS functionality, as well as its SPARC-DQIS Roadmap section describing possible future enhancements to the SPARC-DQIS model.

Model Descriptions

Models are broken up for ease of presentation. Many models share objects, but object detail tables are displayed only once.

GISIO Model: Incoming Data Sets



Shapefile object (gisio_ shapefile)

The Shapefile object holds all the features imported from a single shapefile.

Shapefiles are temporary SPARC objects containing original external data sources before DQIS processes are applied to them and they are transformed into one of the Dynamic Planning models.

Field	Type	Description
attribute_set.all	List	all related gisio.Attribute objects
encoding	String (up to 20)	encoding
feature_set.all	List	all related gisio.Feature objects
filename	String (up to 255)	filename
geom_type	String (up to 50)	geom type
id	Integer	ID
sp_planninglayer_shapefile_set.all	List	all related sp.PlanningLayer objects
srs_wkt	String (up to 255)	srs wkt

Feature object (gisio_ feature)

The Feature object holds a single geographic feature imported from the Shapefile.

Note that there is a many-to-one relationship between features and shapefiles -- that is, each shapefile can have multiple features.

Because we don't know what type of geometry we will be storing, we define separate fields for each of the geometry types the user can edit.

Field	Type	Description
attributevalue_set.all	List	all related gisio.AttributeValue objects
geom_geometrycollection	Geometry collection	geom geometrycollection
geom_multilinestring	Multi-line string	geom multilinestring
geom_multipoint	Multi-point	geom multipoint

Field	Type	Description
geom_multipolygon	Multi polygon	geom multipolygon
geom_point	Point	geom point
id	Integer	ID
shapefile	Shapefile	the related gisio.Shapefile object

Attribute object (gisio_ attribute)

The definition for a single attribute within a shapefile.

Note that there will be one of these for each of the shapefile's attribute definitions.

Attributes are temporary SPARC objects containing original external data sources before DQIS processes are applied to them and they are transformed into one of the Dynamic Inheritance models

Field	Type	Description
attributevalue_set.all	List	all related gisio.AttributeValue objects
id	Integer	ID
name	String (up to 255)	name
precision	Integer	precision
shapefile	Shapefile	the related gisio.Shapefile object
sp_planninglayerfielddefs_attributes_set.all	List	all related sp.PlanningLayerFieldDefs objects
type	Integer	type
width	Integer	width

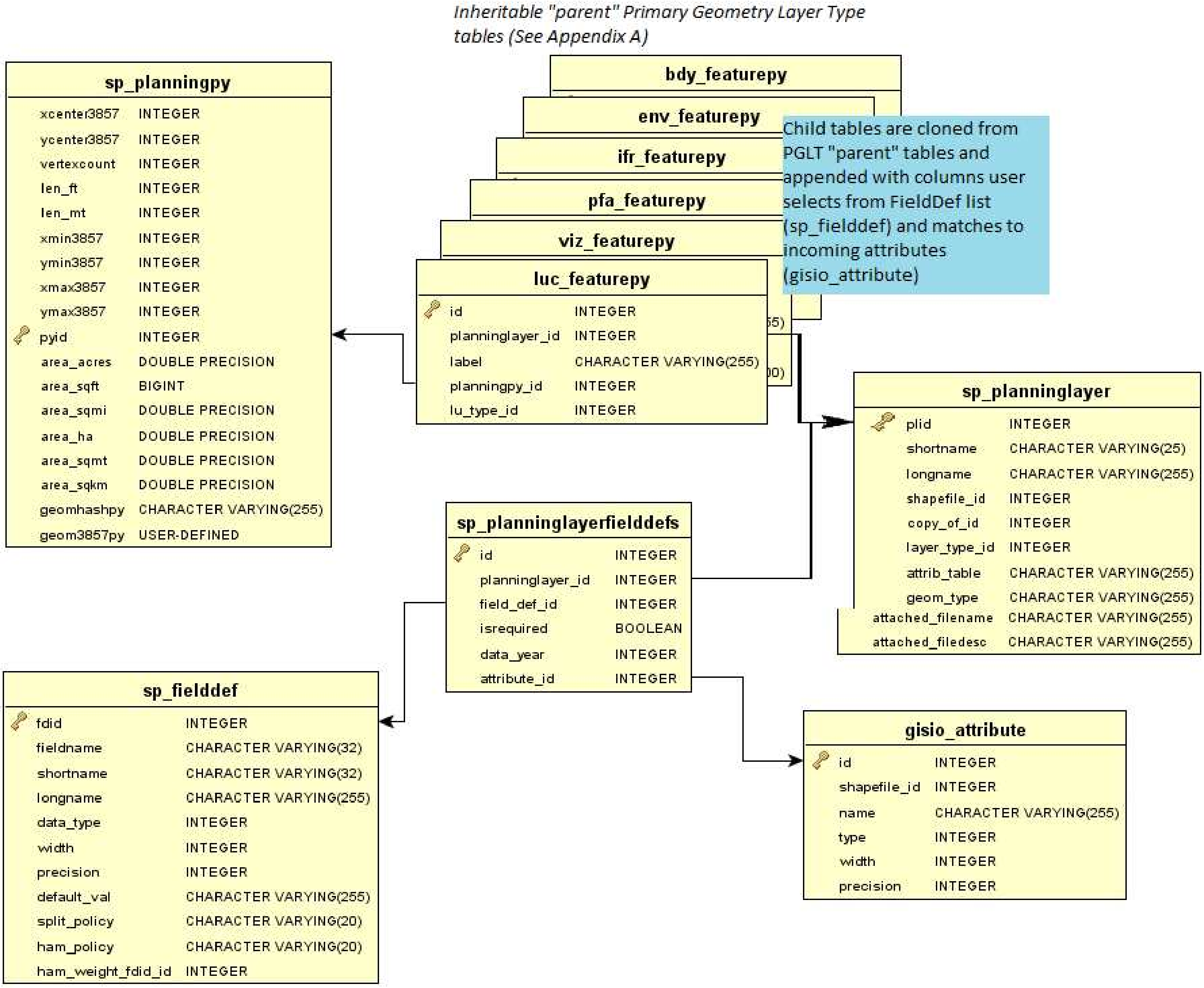
AttributeValue object (gisio_ attributevalue)

The AttributeValue object holds a single attribute value for a geographic feature.

Note that there is a many-to-one relationship between attributes and features -- that is, each feature can have multiple attributes. Similarly, the AttributeValue links to the Attribute the value is for.

Field	Type	Description
attribute	Attribute	the related gisio.Attribute object
feature	Feature	the related gisio.Feature object
id	Integer	ID
value	String (up to 255)	value

Dynamic Planning Layer Model: Polygons



PlanningPy object (sp_planningpy)

Master class holding ALL planning-related polygon features.
Inherits from Feature2D with xy, vertexcount, extent.
One-to-many with all subsequent polygon classes.
e.g. Census Blocks, Parcels, grid cells, policy focus areas.

EPSG 3857, ESRI Web Mercator Auxiliary Sphere.
Includes precalcs for standard planning areas (standard and metric).

Every line coming into database is checked against geomhashpy for identity.
If match with existing, write existing pyid to incoming feature's attrib table.
geomhashpy format (all values whole integers):
xcenter3857 | ycenter3857 | vertexcount | len_ft | area_sqft |
xmin3857 | ymin3857 | xmax3857 | ymax3857

Field	Type	Description
area_acres	Floating point number	area acres - Acres of area in polygon
area_ha	Floating point number	area ha - Hectares of area in polygon
area_sqft	Big (8 byte) integer	area sqft - Square feet of area in polygon (rounded to whole number)
area_sqkm	Floating point number	area sqkm - Square kilometers of area in polygon
area_sqmi	Floating point number	area sqmi - Square miles of area in polygon
area_sqmt	Floating point number	area sqmt - Square meters of area in polygon
geom3857py	Multi polygon	geom3857py - Feature polygon geometry
geomhashpy	String (up to 255)	geomhashpy - Special hash-formatted field describing uniqueness of each geometry and used in eliminating duplicates
id	Integer	id - Polygon ID
len_ft	Integer	len ft - Nearest foot length/perimeter of 2D feature
len_mt	Integer	len mt - Nearest meter length/perimeter of 2D feature
vertexcount	Integer	vertexcount - Number of vertices in feature
xcenter3857	Integer	xcenter3857 - x coordinate representing feature, rounded to nearest meter
xmax3857	Integer	xmax3857 - xmax coordinate to nearest meter of feature extent
xmin3857	Integer	xmin3857 - xmin coordinate to nearest meter of feature extent
ycenter3857	Integer	ycenter3857 - y coordinate representing feature, rounded to nearest meter
ymax3857	Integer	ymax3857 - ymax coordinate to nearest meter of feature extent
ymin3857	Integer	ymin3857 - ymin coordinate to nearest meter of feature extent

PlanningLayer object (sp_planninglayer)

Master table listing all layers, regardless of geometry. Layers are the result of matching an incoming GIS data set (shapefile) with a destination layer_type, and by matching incoming data attributes to SPARC FieldDefs.

Planning Layers (along with their FieldDef selections and the incoming attribute matches stored in sp_planninglayerfielddefs) can be re-used as templates.

Field	Type	Description
attrib_table	String (up to 255)	attrib table - Name in model of inherited attribute table
copy_of	PlanningLayer	the related sp.PlanningLayer object - The shapefile source for this layer
field_defs.all	List	all related sp.FieldDef objects
field_defs.count	Integer	number of related sp.FieldDef objects
geom_type	String (up to 255)	geom type - point line or polygon
id	Integer	id - Point ID
layer_type	LayerType	the related sp.LayerType object - The shapefile source for this layer
longname	String (up to 255)	longname - Layer description (255 chars max)
scenarios.all	List	all related sp.Scenario objects
scenarios.count	Integer	number of related sp.Scenario objects

Field	Type	Description
shapefile	Shapefile	the related gisio.Shapefile object - The shapefile source for this layer
shortname	String (up to 25)	shortname - Layer short name (50 chars max)
attached_filename	String (up to 255)	attached_filename - The name on the server file system hierarchy of the zip/other file uploaded with the layer. Optional.
attached_filedesc	String (up to 255)	attached_filedesc - A description of the contents of the zip/other file uploaded with the layer. Optional.

FieldDef object (sp_fielddef)

The definition of a field to be added dynamically to an inherited PGLT.
Incoming shapefile attributes must be mapped to FieldDefs to be retained in SPARC.

FieldDef-Layer relationships stored in the PlanningLayerFieldDefs table with vintage of data.
FieldDef-Attribute matches also stored in PlanningLayerFieldDefs table.

FieldDefs do not have to be "feature class" specific:
Intention is to re-use them across all layers in a scenario

DATA_TYPES = [("int2", "Boolean"),
("int4", "Short integers"),
("int8", "Long integers"),
("float4", "Single-precision floating point numbers"),
("float8", "Double-precision floating point numbers"),
("text", "Alphanumeric characters"),
("timestamptz", "Date and time data")]

Split policies dictate what happens to the value of a FieldDef when its geometry is broken apart into two or more constituent geometries. Splits can potentially occur during hierarchical aggregation
SPLIT_POLICIES = [("default","Revert to default value"),
("duplicate","Duplicate value into both features"),
("geom_ratio", "Divide value among both feature according to geometry size")]

HAM (Hierarchical Aggregation Model) policies dictate what happens to the value of a FieldDef when two or more geometries-- all belonging to the same coarser-grained polygon in the next layer up in the hierarchy-- are combined during aggregation. The "weight_avg" option also requires a reference to another FieldDef in the ham_weight_fdid field.
HAM_POLICIES = [("default","Revert to default value"),
("sum","Sum values into parent aggregate feature"),
("dominant","Sum values into parent aggregate feature"),
("geom_avg", "Aggregate value is average of child values weighted by child feature size"),
("fd_avg", "Aggregate value is average of child values weighted by another FieldDef")]

Field	Type	Description
data_type	Integer	data type - Field data type (integer)
default_val	String (up to 255)	default val - FieldDef default value (32 chars max)
fielddef_fielddef_set.all	List	all related sp.FieldDef objects
fieldname	String (up to 32)	fieldname - Field name used in dynamic ADD COLUMNN sql statement
ham_policy	String (up to 20)	ham policy - How values are combined when aggregation occurs
ham_weight_fdid	FieldDef	the related sp.FieldDef object

Field	Type	Description
		- Related FieldDef that is source for aggregation weighting
id	Integer	id - Field Definition ID
longname	String (up to 255)	longname - FieldDef description (255 chars max)
precision	Integer	precision - Data type precision (integer)
shortname	String (up to 32)	shortname - FieldDef short name alias (32 chars max)
sp_planninglayer_fielddefs_set.all	List	all related sp.PlanningLayer objects
split_policy	String (up to 20)	split policy - How value is divided when associated feature is split
width	Integer	width - Field width (integer)

PlanningLayerFieldDefs object (sp_planninglayerfielddefs)

Many-to-many relationship table connecting FieldDefs to planning layers and incoming attributes.

Field	Type	Description
attribute	Attribute	the related gisio.Attribute object
data_year	Integer	data year - The measurement year or vintage of the data in this layer's FieldDef
field_def	FieldDef	the related sp.FieldDef object - The field definition
id	Integer	ID
isrequired	Boolean (Either True or False)	isrequired - Is this field definition required when uploading to this layer?
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The planning layer

BoundaryFeaturePy "parent" object (bdy_featurepy)

Abstract class holding fields common to all planning boundaries polygon features.
Inherited by ccensus blocks, census block groups, tracts etc.
see following links:
http://www.census.gov/prod/cen2010/doc/sf1.pdf
http://www.census.gov/geo/www/geodiagram.html
http://www.census.gov/cgi-bin/geo/shapefiles2010/main
http://www2.census.gov/census_2010/04-Summary_File_1/

Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningpy	PlanningPy	the related sp.PlanningPy object - Planning polygon from table of unique shapes

LandUseCanvasFeaturePy "parent" object (luc_featurepy)

Abstract class holding fields common to all paintable land-use polygon features.
Inherited by parcels, grid, etc.

Field	Type	Description

Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
lu_type	LandUseType	the related sp.LandUseType object - The feature land-use type
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningpy	PlanningPy	the related sp.PlanningPy object - Polygon from table of unique shapes

InfrastructureFeaturePy "parent" object (ifr_featurepy)

Abstract class holding fields common to all Infrastructure polygon features.
Inherited by water, sewer, other service areas, etc.

Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningpy	PlanningPy	the related sp.PlanningPy object - Polygon from table of unique shapes

EnvironmentFeaturePy "parent" object (env_featurepy)

Abstract class holding fields common to all environmental polygon features.
Inherited by floodplains, watersheds, wetlands, etc.

Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningpy	PlanningPy	the related sp.PlanningPy object - Polygon from table of unique shapes

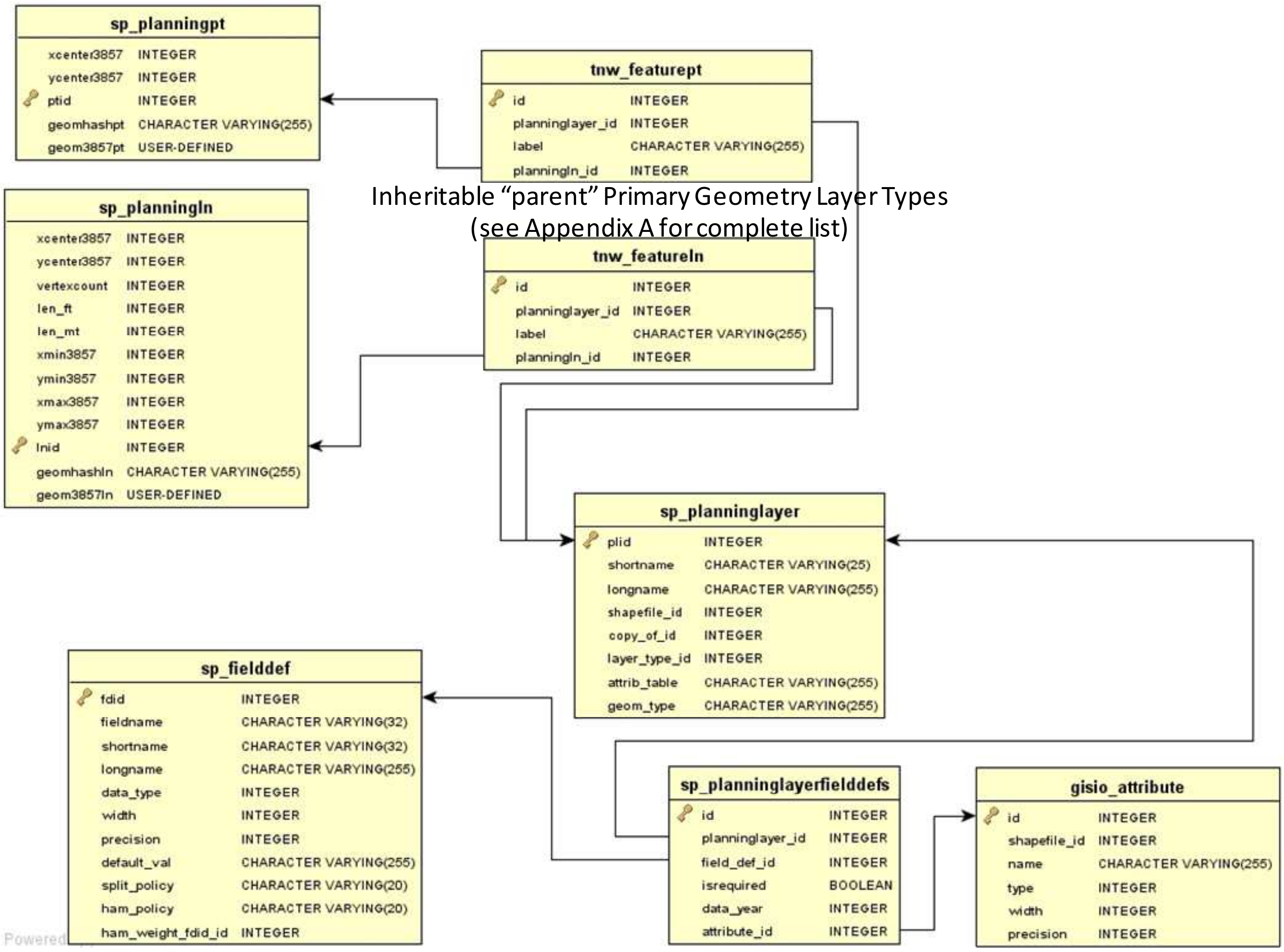
VisualizeFeaturePy "parent" object (viz_featurepy)

Abstract class holding fields common to all 3D or other visualization feature objects.
Inherited by Ground cover, Building Footprints, etc.

Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningpy	PlanningPy	the related sp.PlanningPy object - Polygon from table of unique shapes
viz_obj	File path	viz obj - The renderable object

Dynamic Planning Layer Model: Transportation Network

Other objects miscellaneous line and point objects (e.g. traffic control devices) also share use of sp_planningln and sp_planningpt.



PlanningPt object (sp_planningpt)

Master class holding ALL planning-related point features.
Inherits from Feature1D with xy.
One-to-many to point classes like OD or others like network nodes.
e.g. network origin/dest, point of interest, network node, network access pt.

EPSG 3857, ESRI Web Mercator Auxiliary Sphere.

Every point coming into database is checked against geomhashpt for identity.
If match with existing, write existing ptid to incoming feature's attrib table.
geomhashpt format (all values whole integers):
xcenter3857 | ycenter3857

Field	Type	Description
geom3857pt	Point	geom3857pt - Feature point geometry
geomhashpt	String (up to 255)	geomhashpt - Special hash-formatted field describing uniqueness of each geometry and used in eliminating duplicates

Field	Type	Description
id	Integer	id - Point ID
sp_infrastructurefeaturept_planningpt_set.all	List	all related sp.InfrastructureFeaturePt objects
sp_infrastructurefeaturept_planningpt_set.count	Integer	number of related sp.InfrastructureFeaturePt objects
sp_transportationfeaturept_planningpt_set.all	List	all related sp.TransportationFeaturePt objects
sp_transportationfeaturept_planningpt_set.count	Integer	number of related sp.TransportationFeaturePt objects
sp_visualizefeaturept_planningpt_set.all	List	all related sp.VisualizeFeaturePt objects
sp_visualizefeaturept_planningpt_set.count	Integer	number of related sp.VisualizeFeaturePt objects
xcenter3857	Integer	xcenter3857 - x coordinate representing feature, rounded to nearest meter
ycenter3857	Integer	ycenter3857 - y coordinate representing feature, rounded to nearest meter

PlanningLn object (sp_planningln)

Master class holding ALL planning-related line features.
Inherits from Feature2D with xy, vertexcount, extent.
One-to-many with all subsequent line classes.
e.g. ped network, street centerlines, transit routes.

EPSG 3857, ESRI Web Mercator Auxiliary Sphere.
Includes precalcs for standard planning areas (standard and metric).

Every line coming into database is checked against geomhashln for identity.
If match with existing, write existing lnid to incoming feature's attrib table.
geomhashln format (all values whole integers):
xcenter3857 | ycenter3857 | vertexcount | len_ft |
xmin3857 | ymin3857 | xmax3857 | ymax3857

Field	Type	Description
geom3857ln	Line string	geom3857ln - Feature line geometry
geomhashln	String (up to 255)	geomhashln - Special hash-formatted field describing uniqueness of each geometry and used in eliminating duplicates
id	Integer	id - Line ID
len_ft	Integer	len ft - Nearest foot length/perimeter of 2D feature
len_mt	Integer	len mt - Nearest meter length/perimeter of 2D feature
vertexcount	Integer	vertexcount - Number of vertices in feature
xcenter3857	Integer	xcenter3857 - x coordinate representing feature, rounded to nearest meter
xmax3857	Integer	xmax3857 - xmax coordinate to nearest meter of feature extent
xmin3857	Integer	xmin3857 - xmin coordinate to nearest meter of feature extent
ycenter3857	Integer	ycenter3857 - y coordinate representing feature, rounded to nearest meter
ymax3857	Integer	ymax3857 - ymax coordinate to nearest meter of feature extent
ymin3857	Integer	ymin3857 - ymin coordinate to nearest meter of feature extent

TransportationFeaturePt object (tnw_featurept)

Abstract class holding fields common to all transportation network points.
Inherited by network junctions, origins, destinations, transit stops, etc.

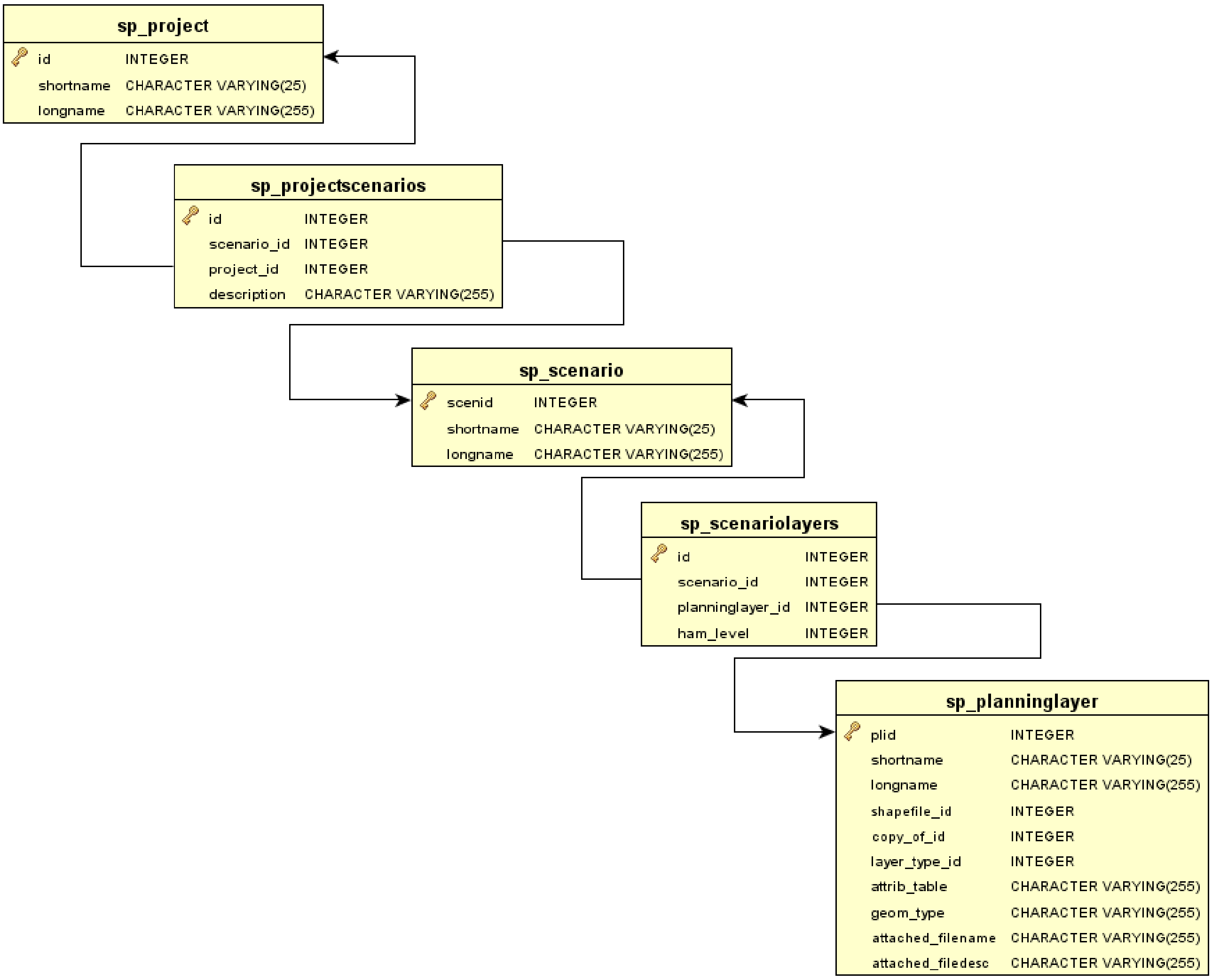
Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningpt	PlanningPt	the related sp.PlanningPt object - Point from table of unique shapes

TransportationFeatureLn object (tnw_featureln)

Abstract class holding fields common to all transportation network lines.
Inherited by ped routes, street centerlines, transit routes, bicycle routes, etc.

Field	Type	Description
id	Integer	ID
label	String (up to 255)	label - Feature label (255 chars max)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The layer to which this feature belongs
planningln	PlanningLn	the related sp.PlanningLn object - Line from table of unique shapes

Project-Scenario Model



Project object (sp_project)

Project is as organizational model linking a user-selected set of scenario together.
One scenario can belong to many projects.

Field	Type	Description
id	Integer	ID
longname	String (up to 255)	longname - Project description (255 chars max)
shortname	String (up to 25)	shortname - Project short name (50 chars max)
sp_projectscenarios_project_set.all	List	all related sp.ProjectScenarios objects
sp_scenario_projects_set.all	List	all related sp.Scenario objects

ProjectScenarios object (sp_project)

Many-to-many relationship table linking projects and scenarios.
One scenario can belong to many projects.

Field	Type	Description
description	String (up to 255)	description - Description of scenario's role in project (255 chars max)
id	Integer	ID
project	Project	the related sp.Project object - The scenario project
scenario	Scenario	the related sp.Scenario object - The scenario

Scenario object (sp_scenario)

Scenario is an organizational model linking a user-selected set of layers together.
One layer can belong to many scenarios.

Field	Type	Description
id	Integer	id - Scenario ID
longname	String (up to 255)	longname - Scenario description (255 chars max)
projects.all	List	all related sp.Project objects
shortname	String (up to 25)	shortname - Scenario short name (50 chars max)
sp_planninglayer_scenarios_set.all	List	all related sp.PlanningLayer objects

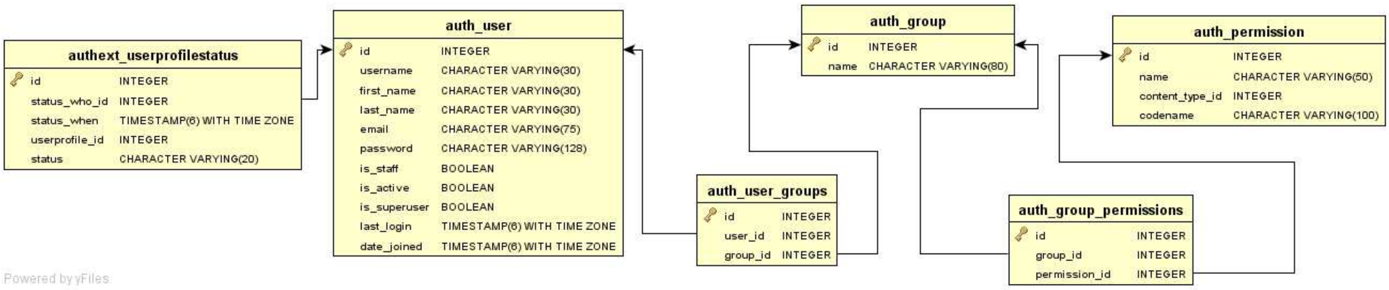
ScenarioLayers object (sp_scenariolayers)

Many-to-many relationship table connecting scenarios to planning layers
Possible to support Hiearchical Aggregation Model (HAM) parameters here

Field	Type	Description
id	Integer	ID
ham_level	Integer	ham level - The level that this (polygonal) layer sits in the hiearchical aggregation model (HAM) hierarchy. 1 is the top level for desired aggregation (e.g. Region)
planninglayer	PlanningLayer	the related sp.PlanningLayer object - The planning layer
scenario	Scenario	the related sp.Scenario object - The scenario

User Authentication, Object Status and Group Permissions Model

This model is adopted from the basic Django MVC application, customized to include the object status component.



User object (auth_user)

Users within the authentication system are represented by this model.

Username and password are required. Other fields are optional.

Field	Type	Description
date_joined	Date (with time)	date joined
email	E-mail address	e-mail address
first_name	String (up to 30)	first name
get_full_name		Returns the first_name plus the last_name, with a space in between.
get_profile		Returns site-specific profile for this user. Raises SiteProfileNotAvailable if this site does not allow profiles.
groups.all	List	all related auth.Group objects
id	Integer	ID
is_active	Boolean (Either True or False)	active - Designates whether this user should be treated as active. Unselect this instead of deleting accounts.
is_anonymous		Always returns False. This is a way of comparing User objects to anonymous users.
is_authenticated		Always return True. This is a way to tell if the user has been authenticated in templates.
is_staff	Boolean (Either True or False)	staff status - Designates whether the user can log into this admin site.
is_superuser	Boolean (Either True or False)	superuser status - Designates that this user has all permissions without explicitly assigning them.
last_login	Date (with time)	last login
last_name	String (up to 30)	last name
logentry_set.all	List	all related admin.LogEntry objects
logentry_set.count	Integer	number of related admin.LogEntry objects
password	String (up to 128)	password - Use '[algo]$[salt]$[hexdigest]' or use the change password form.
user_permissions.all	List	all related auth.Permission objects
username	String (up to 30)	username - Required. 30 characters or fewer. Letters, numbers and @/./+/-/_ characters

UserProfileStatus object (authext_userprofilestatus)

The UserProfileStatus object holds a log of the changes made to a user's status, from submission of self-registration requests to access revocation.

The abstract Status object can be re-used to track user actions on any object, such as Layers, Shapefiles, FieldDefs, etc.

Field	Type	Description
id	Integer	ID
status	String (up to 20)	status - User status (as of date)
status_when	Date (with time)	status when - DateTime stamp of status change
status_who	User	the related auth.User object - User who applied the status change
userprofile	UserProfile	the related authext.UserProfile object - Shapefile filename

Group object (auth_group)

Groups are a generic way of categorizing users to apply permissions, or some other label, to those users. A user can belong to any number of groups.

A user in a group automatically has all the permissions granted to that group. For example, if the group Site editors has the permission can_edit_home_page, any user in that group will have that permission.

Beyond permissions, groups are a convenient way to categorize users to apply some label, or extended functionality, to them. For example, you could create a group 'Special users', and you could write code that would do special things to those users -- such as giving them access to a members-only portion of your site, or sending them members-only e-mail messages.

Field	Type	Description
id	Integer	ID
name	String (up to 80)	name
permissions.all	List	all related auth.Permission objects
permissions.count	Integer	number of related auth.Permission objects
user_set.all	List	all related auth.User objects
user_set.count	Integer	number of related auth.User objects

Permission object (auth_permission)

The permissions system provides a way to assign permissions to specific users and groups of users.

The permission system is used by the admin site, but may also be useful in your own code. The admin site uses permissions as follows:

- The "add" permission limits the user's ability to view the "add" form and add an object.
- The "change" permission limits a user's ability to view the change list, view the "change" form and change an object.
- The "delete" permission limits the ability to delete an object.

Permissions are set globally per type of object, not per specific object instance. It is possible to say "Mary may change news stories," but it's not currently possible to say "Mary may change news stories, but only the ones she created herself" or "Mary may only change news stories that have a certain status or publication date."

Three basic permissions -- add, change and delete -- are automatically created for each model.

Field	Type	Description
codename	String (up to 100)	codename
content_type	ContentType	the related contenttypes.ContentType object
group_set.all	List	all related auth.Group objects
group_set.count	Integer	number of related auth.Group objects
id	Integer	ID
name	String (up to 50)	name
natural_key		None
user_set.all	List	all related auth.User objects
user_set.count	Integer	number of related auth.User objects

SPARC-Related Sustainable Places Project Deliverables

SQL Development

In July 2012, following approval of the finalized MetaSchema document, PostgreSQL-compliant SQL scripts will be developed that can be executed on a server to generate table objects, query views, and triggers/functions designed to manage some of the dynamic elements of the MetaSchema.

Additionally, initial data sets for some of the table objects will be created and incorporated into the MetaSchema-generation scripts.

Test SPARC / DQIS Implementation

In August 2012, a limited test implementation of both the SPARC database and the DQIS application will be deployed on a Linux development server hosted by Criterion. User acceptance testing will be permitted on the development server.

Production SPARC Database Server Implementation

In September 2012, utilizing a dedicated Linux server instance provided by TACC, a PostgreSQL/PostGIS database stack will be built and the SPARC schema installed.

Production DQIS Application Server Implementation

In September 2012, utilizing a second Linux server instance provided by TACC, a Python/Django/Apache/WSGI/OGR software stack will be built and the DQIS application installed.

Appendix A: List of inheritable Primary Geometric Layer Types (PGLT)

Layer Group	Geometry SubGroup	Layer Type	Base Field Definition(s)
Planning Boundary (PB)	Polygons	Maximum Geographic Boundary (MGB)	
Any collection of political, administrative or user-defined boundaries. Boundaries define desirable levels of aggregation for scenario planning indicator scores. Features can also be supplied with attributes assembled from census or other sources (e.g. SLD).		States (Nest)	Census GeoID
		Census County (Nest)	Census GeoID
		Census County subdivision (Nest)	Census GeoID
		Census Place (Nest)	Census GeoID
		Census Tract (Nest)	Census GeoID
		Census Block group (Nest)	Census GeoID
		Census Block (Nest)	Census GeoID
		Census Zip code tabulation area (ZCTA)	
		Census Urbanized area	
		Census Urban cluster	
		Census School district	
		Census Incorporated place	
		Census designated place	
		Census Metropolitan statistical area	
		Census Micropolitan statistical area	
		Census Traffic Analysis Zones	
		City Limits / Unincorporated Lands	
		MPO Boundary	
		MPO Traffic Analysis Zones	
		Urban Areas	
		SubRegions	
		Transit Station Areas	
		Corridors	
		Centers	
		Aggregation Grid Cells	
		Transit Agency Boundaries	
		Custom Boundaries	Description
	Lines	Planning Boundary Cordon	
	Points	(n/a)	
LandUse Canvas (LUC)	Polygons	Parcels Canvas (Existing Land Use)	LandUseType
Any land-use layer whose function is as a canvas for land-use scenario painting. A land-use classification attribute for each of the layer's features is required.		Grid Cells Canvas	LandUseType
		Planned Land Use Canvas	LandUseType
		Comprehensive Plan Canvas	LandUseType
		Building Footprints Canvas	LandUseType
		Zoned Land Use Canvas	LandUseType
		Traffic Analysis Zones Canvas	LandUseType
		Census Blocks Canvas	LandUseType

Layer Group	Geometry SubGroup	Layer Type	Base Field Definition(s)
		Custom Canvas (e.g. Parking Lots)	Description, LandUseType
	Lines	(n/a)	
	Points	(n/a)	
Transportation (TNW)	Polygons	Custom Polygon Transportation Features	Description
The set of layers used to compute travel times and distances from origins to destinations via one or more different modes of travel.	Lines	Street Centerlines	Functional Class
		Pedestrian Routes	
		Bicycle Routes	
		Bus Routes	
		Streetcar Routes	
		BRT Routes	
		Light Rail Lines	
		Commuter Rail Lines	
		Network O-D Solution Paths	
		Custom Line Transportation Features	Description
	Points	Transit Stop Points	
		Residential Trip Origin Points	
		Residential Trip Destination Points	
		NonRes Trip Origin Points	
		NonRes Trip Destination Points	
		Network O-D Access Points	
		Traffic Control Devices	
		Custom Point Transportation Features	Description
Infrastructure (IFR)	Polygons	Water Service Areas	
The set of layers defining the location of infrastructure important to the scenario planning process (indicators).		Wastewater Service Areas	
		Utility Service Areas	
		Stormwater Service Areas	TSS%, Phos%, NPSP%
		School Attendance Areas	
		Custom Polygon Infrastructure Features	Description
	Lines	Custom Line Infrastructure Features	Description
	Points	Schools	
		Hospitals	
		Major Civic Facilities	
		On-street Parking (points)	
		Custom Point Infrastructure Features	Description

Layer Group	Geometry SubGroup	Layer Type	Base Field Definition(s)
Environment (ENV)	Polygons	Soils	Hydrological Group
The set of layers describing features of the natural environment important to the scenario planning process (indicators).		Steep Slope Areas	Slope Percent
		Floodplains	Floodplain Year
		Water Bodies	
		Wetlands	
		Climate Zones	Zone Number
		Habitat	Species
		Watersheds	
		Impervious Surface	
		Tree Canopy	
		Custom Polygon Environment Features	Description
	Lines	Custom Line Environment Features	Description
3D Feature Footprints (VIZ)	Polygons	Building Footprints	3D Model
Layers whose features represent physical objects, from building footprints to the locations of trees.		Surface Parking Lots (poly)	3D Model
		Ground cover polygons	3D Model
		Custom Polygon Feature Footprints	Description, 3D Model
	Lines	Fences and walls	3D Model
		Setbacks	3D Model
		Custom Line Feature Footprints	Description, 3D Model
	Points	Tree Points	3D Model
		Street furniture	3D Model
		Vehicle Points	3D Model
		Pedestrian Points	3D Model
		Sign Points	3D Model
		Custom Point Feature Footprints	Description, 3D Model
Policy Focus Areas (PFA)	Polygons	Development Incentive	Policy Description, Weighting
Sets of polygonal layers that are intended to influence scenario design.		Preservation Incentive	Policy Description, Weighting
	Lines	(n/a)	
	Points	(n/a)	

Appendix B: List of all FieldDefs supplied in a default SPARC implementation

CLASSIFICATION	ORIGIN	Attribute	Field Name	Field Type	Split Policy	HAM Policy	Weight
Building Characteristic	Frego Attrib Table	Average FAR	avg_FAR	double	Duplicate	WeightedAverage	Acres
Building Characteristic	Frego Attrib Table	% Rental	Rental_per	double	Duplicate	WeightedAverage	Acres
Building Characteristic	Frego Attrib Table	Energy Use (BTU)	btu	double	GeomRatio	Sum	(n/a)
Building Characteristic	Frego Attrib Table	GHG Emissions (Tons/Yr)	ghg	double	GeomRatio	Sum	(n/a)
Building Characteristic	Frego Attrib Table	Internal Water Consumption (G/Day)	intl_wtr	double	GeomRatio	Sum	(n/a)
Building Characteristic	Frego Attrib Table	Waste Water (G/Day)	wst_wtr	double	GeomRatio	Sum	(n/a)
Building Characteristic	Frego Attrib Table	Solid Waste (lbs/Day)	sol_wst	double	GeomRatio	Sum	(n/a)
Building Characteristic	IX Indicator	Residential Building Energy Use (MMBtu/yr/capita)	ResidentialBuildingEnergyUse	Double	Duplicate	WeightedAverage	POP
Building Characteristic	IX Indicator	Non-Residential Building Energy Use (MMBtu/yr/emp)	Non-ResidentialBuildingEnergyUse	Double	Duplicate	WeightedAverage	EMP
Building Characteristic	IX Indicator	Residential Building CO2 Emissions (lbs/capita/yr)	ResidentialBuildingCO2Emissions	Double	Duplicate	WeightedAverage	POP
Building Characteristic	IX Indicator	Non-Residential Building CO2 Emissions (lbs/emp/yr)	Non-ResidentialBuildingCO2Emissions	Double	Duplicate	WeightedAverage	EMP
Classification	Frego Attrib Table	Development Type Name	dev_type	Text	Duplicate	DominantValue	dev_type
Classification	IX Street Centerlines	Functional Class	FunctionalClass	Text	Duplicate	DominantValue	Length
Classification	IX Hydrological Soils	Hydrological Group	HydrologicalGroup	Text	Duplicate	DominantValue	Acres
Combined Building/Travel	IX Indicator	Residential Total Energy Use (MMBtu/yr/capita)	ResidentialTotalEnergyUse	Double	Duplicate	WeightedAverage	POP
Combined Building/Travel	IX Indicator	Non-Residential Total Energy Use (MMBtu/yr/emp)	Non-ResidentialTotalEnergyUse	Double	Duplicate	WeightedAverage	EMP
Combined Building/Travel	IX Indicator	Residential Total CO2 Emissions (lbs/capita/yr)	ResidentialTotalCO2Emissions	Double	Duplicate	WeightedAverage	POP
Combined Building/Travel	IX Indicator	Non-Residential Total CO2 Emissions (lbs/emp/yr)	Non-ResidentialTotalCO2Emissions	Double	Duplicate	WeightedAverage	EMP
Combined Jobs/Housing	IX Indicator	Jobs to Housing Balance (jobs/DU)	JobstoHousingBalance	Double	Duplicate	WeightedAverage	HU+EMP
Deltas of Change	Frego Attrib Table	Redevelopment Rate	Redev_Rate	double			
Deltas of Change	Frego Attrib Table	Redev Housing Unit Density	DevdHUDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Job Density	DevdEMPDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Single Family Density	DevdSFDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Townhome Density	DevdTHDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Multifamily Density	DevdMFDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Mobile Home Density	DevdMHDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Retail Density	DevdRETDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Office Density	DevdOFFDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	Frego Attrib Table	Redev Industrial Density	DevdINDDen	double	Duplicate	WeightedAverage	Acres
Deltas of Change	IX Indicator	Residential Infill (new pop)	ResidentialInfill	Double	GeomRatio	Sum	(n/a)
Deltas of Change	IX Indicator	Employment Infill (new emps)	EmploymentInfill	Double	GeomRatio	Sum	(n/a)
Dollars	Frego Attrib Table	Average Household Income	Avg_HH_Inc	double	Duplicate	WeightedAverage	HU
Dollars	Frego Attrib Table	Average Land Cost	lnd_cst	double	Duplicate	WeightedAverage	Acres
Dollars	Frego Attrib Table	Average Rent	rent	double	Duplicate	WeightedAverage	Acres
Dollars	Frego Attrib Table	Average Sales Price	sale_pr	double	Duplicate	WeightedAverage	Acres
Dollars	Frego Attrib Table	Average Building Value	bldg_val	double	Duplicate	WeightedAverage	Acres
Dollars	Frego Attrib Table	Property Tax ($/Yr)	prop_tax	double	GeomRatio	Sum	(n/a)
Dollars	Frego Attrib Table	Sales Tax ($/Yr)	sales_tax	double	GeomRatio	Sum	(n/a)
Dollars	IX Indicator	Fiscal Impact of Development (dollars)	FiscalImpactofDevelopment	Double	GeomRatio	Sum	(n/a)

CLASSIFICATION	ORIGIN	Attribute	Field Name	Field Type	Split Policy	HAM Policy	Weight
Dollars	IX Indicator	Single-Family Housing Affordability (affordable price/120% value ratio)	Single-FamilyHousingAffordability	Double	Duplicate	WeightedAverage	SF
Environmental	IX Indicator	NOx Pollutant Emissions (lbs/capita/yr)	NOxPollutantEmissions	Double	Duplicate	WeightedAverage	POP
Environmental	IX Indicator	HC Pollutant Emissions (lbs/capita/yr)	HCPollutantEmissions	Double	Duplicate	WeightedAverage	POP
Environmental	IX Indicator	CO Pollutant Emissions (lbs/capita/yr)	COPollutantEmissions	Double	Duplicate	WeightedAverage	POP
Environmental	IX Indicator	Open Space Share (% total area)	OpenSpaceShare	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Indicator	Open Space Connectivity (0-1 scale)	OpenSpaceConnectivity	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Indicator	Stormwater Runoff (cu ft/acre/yr)	StormwaterRunoff	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Indicator	Nonpoint Pollution (kg/acre/yr)	NonpointPollution	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Indicator	Floodplain Encroachment (% study area w/i floodplain)	FloodplainEncroachment	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Stormwater BMP	TSS Removal (%)	TSSRemovalPct	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Stormwater BMP	Phosphate Removal (%)	PhosphateRemovalPct	Double	Duplicate	WeightedAverage	Acres
Environmental	IX Stormwater BMP	Nitrogen Removal (%)	NitrogenRemovalPct	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Street Percentage	Streets	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Civic Percentage	Civic	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Park Percentage	Park	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Net Land Percentage	Net_Land	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Net Buildable Acre	net_acre	double	GeomRatio	Sum	(n/a)
Land Characteristic	Frego Attrib Table	Street Miles per Acre	Strt_Mi_Acre	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Land Miles per Acre	Ln_Mi_Acre	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Intersection Density per Sq Mi	IntDen_Mi	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Green Street Percentage	green_street	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Public Impervious Percentage	Public_Imperv	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Building Impervious %	Net_Imperv	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Gross Impervious %	Gross_Imperv	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Land Use Mix Score	LANDMIX	double	Duplicate	WeightedAverage	Acres
Land Characteristic	Frego Attrib Table	Landscaping Water Use (G/Day)	lndscp_wtr	double	GeomRatio	Sum	(n/a)
Land Characteristic	Frego Attrib Table	Parking Spaces	prkg_spcs	double	GeomRatio	Sum	(n/a)
Land Characteristic	Frego Attrib Table	Parking Square Feet	prkg_sqft	double	GeomRatio	Sum	(n/a)
Land Characteristic	IXLandUseCanvas	Landscape Type Water Use Factor	LandscapeTypeWaterUseFactor	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IXLandUseCanvas	Nitrogen in Runoff (mg/L)	Nitrogen	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IXLandUseCanvas	Phosphates in Runoff (mg/L)	Phosphates	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IXLandUseCanvas	Total Suspended Solids in Runoff (mg/L)	TSS	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IXLandUseCanvas	Required Parking Spaces	RequiredParkingSpaces	Double	GeomRatio	Sum	(n/a)
Land Characteristic	IXLandUseCanvas	CO2 Sequestered (lbs/yr)	CO2Sequestered	Double	GeomRatio	Sum	(n/a)
Land Characteristic	IX Indicator	Study Area Acreage (total acres)	StudyAreaAcreage	Double	GeomRatio	Sum	(n/a)
Land Characteristic	IX Indicator	Average Parcel Size (AverageParcelSize)	AverageParcelSize	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IX Indicator	Use Balance (0-1 scale)	UseBalance	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IX Indicator	Development Footprint (gross acres/1000 residents)	DevelopmentFootprint	Double	Duplicate	WeightedAverage	POP
Land Characteristic	IX Indicator	Land Suitability (% vacant land developable)	LandSuitability	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IX Indicator	Average CO2 Sequestration (lbs/acre/yr)	AverageCO2Sequestration	Double	Duplicate	WeightedAverage	Acres
Land Characteristic	IX Slopes	Slope Percent	SlopePercent	Double	Duplicate	WeightedAverage	Acres

CLASSIFICATION	ORIGIN	Attribute	Field Name	Field Type	Split Policy	HAM Policy	Weight
Land Characteristic	IX Hydrological Soils	Treat Soil As Non-Buildable	TreatAsNonBuildable	Short Int	Duplicate	WeightedAverage	Acres
NonRes Demographic	Implied Frego Attrib	Employment Count	EMP	double	GeomRatio	Sum	(n/a)
NonRes Demographic	Implied Frego Attrib	Retail Density Count	RET	double	GeomRatio	Sum	(n/a)
NonRes Demographic	Implied Frego Attrib	Office Density Count	OFF	double	GeomRatio	Sum	(n/a)
NonRes Demographic	Implied Frego Attrib	Industrial Count	IND	double	GeomRatio	Sum	(n/a)
NonRes Demographic	Frego Attrib Table	Net Job Density	NetEMPDen	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Job Density	EMPDen	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Retail Density	RETDen	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Office Density	OFFDen	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Industrial Density	INDDen	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Retail Employee Percentage	RET_per	double	Duplicate	WeightedAverage	EMP
NonRes Demographic	Frego Attrib Table	Office Employee Percentage	OFF_per	double	Duplicate	WeightedAverage	EMP
NonRes Demographic	Frego Attrib Table	Industrial Employee Percentage	IND_per	double	Duplicate	WeightedAverage	EMP
NonRes Demographic	Frego Attrib Table	Retail SqFt per Net Acre	RetSqFtNetAc	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Office SqFt per Net Acre	OffSqFtNetAc	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Industrial SqFt per Net Acre	IndSqFtNetAc	double	Duplicate	WeightedAverage	Acres
NonRes Demographic	Frego Attrib Table	Percent Retail SqFt per Net Acre	per_RetAc	double	Duplicate	WeightedAverage	TOTSQFT
NonRes Demographic	Frego Attrib Table	Percent Office SqFt per Net Acre	per_OffAc	double	Duplicate	WeightedAverage	TOTSQFT
NonRes Demographic	Frego Attrib Table	Percent Industrial SqFt per Net Acre	per_IndAc	double	Duplicate	WeightedAverage	TOTSQFT
NonRes Demographic	IXLandUseCanvas	Employment Floor Area (sqft)	CommercialFloorArea	Double	GeomRatio	Sum	(n/a)
NonRes Demographic	IXLandUseCanvas	EmploymentCountMFG	EmploymentCountMFG	Double	GeomRatio	Sum	(n/a)
NonRes Demographic	IXLandUseCanvas	EmploymentCountOTH	EmploymentCountOTH	Double	GeomRatio	Sum	(n/a)
NonRes Demographic	IXLandUseCanvas	EmploymentCountSVC	EmploymentCountSVC	Double	GeomRatio	Sum	(n/a)
NonRes Demographic	IXLandUseCanvas	Non-Res Embodied CO2 (lbs/yr)	CO2EmbodiedNonRes	Double	GeomRatio	Sum	(n/a)
NonRes Demographic	IXLandUseCanvas	Non-Res Operations Energy (MMBtu/yr)	EnergyOperationsNonRes	Double	GeomRatio	Sum	(n/a)
NonRes Demographic	IX Indicator	Conforming Employment Density (emps/gross acre)	ConformingEmploymentDensity	Double	Duplicate	WeightedAverage	Acres
NonRes Demographic	IX Indicator	Commercial Building Density (avg FAR)	CommercialBuildingDensity	Double	Duplicate	WeightedAverage	ComSqFt
NonRes Demographic	IX Planned Land-Use	Residential Conformance	ResidentialConformance	Short Int	Duplicate	WeightedAverage	Acres
NonRes Location	IX Indicator	Transit Adjacency to Employment (% emps w/i user buffer)	TransitAdjacencytoEmployment	Double	Duplicate	WeightedAverage	EMP
NonRes Location	IX Indicator	Key Feature Adjacency to Employment (% emps w/i user buffers)	KeyFeatureAdjacencytoEmployment	Double	Duplicate	WeightedAverage	EMP
NonRes Location	IX Indicator	Transit Proximity to Employment (avg walk ft to closest)	TransitProximitytoEmployment	Double	Duplicate	WeightedAverage	EMP
Residential Demographic	Implied Frego Attrib	Housing Unit Count	HU	double	GeomRatio	Sum	(n/a)
Residential Demographic	Implied Frego Attrib	Single Family Unit Count	SF	double	GeomRatio	Sum	(n/a)
Residential Demographic	Implied Frego Attrib	Townhome Unit Count	TH	double	GeomRatio	Sum	(n/a)
Residential Demographic	Implied Frego Attrib	Multifamily Unit Count	MF	double	GeomRatio	Sum	(n/a)
Residential Demographic	Implied Frego Attrib	Mobile Home Unit Count	MH	double	GeomRatio	Sum	(n/a)
Residential Demographic	Implied Frego Attrib	Population	POP	double	GeomRatio	Sum	(n/a)
Residential Demographic	Frego Attrib Table	Net Housing Unit Density	NetHUDen	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Housing Unit Density	HUDen	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Single Family Density	SFDen	double	Duplicate	WeightedAverage	Acres

CLASSIFICATION	ORIGIN	Attribute	Field Name	Field Type	Split Policy	HAM Policy	Weight
Residential Demographic	Frego Attrib Table	Townhome Density	THDen	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Multifamily Density	MFDen	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Mobile Home Density	MHDen	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Single Family Percentage	SF_per	double	Duplicate	WeightedAverage	HU
Residential Demographic	Frego Attrib Table	Townhome Percentage	TH_per	double	Duplicate	WeightedAverage	HU
Residential Demographic	Frego Attrib Table	Multifamily Percentage	MF_per	double	Duplicate	WeightedAverage	HU
Residential Demographic	Frego Attrib Table	Mobile Home Percentage	MH_per	double	Duplicate	WeightedAverage	HU
Residential Demographic	Frego Attrib Table	People per Acre	ppl_acre	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Average Household Size	avg_hh_size	double	Duplicate	WeightedAverage	HU
Residential Demographic	Frego Attrib Table	Single Family SqFt per Net Acre	SFSqFtNetAc	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Townhome SqFt per Net Acre	THSqFtNetAc	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Multifamily SqFt per Net Acre	MFSqFtNetAc	double	Duplicate	WeightedAverage	Acres
Residential Demographic	Frego Attrib Table	Percent Single Family SqFt per Net Acre	per_SFAc	double	Duplicate	WeightedAverage	TOTSQFT
Residential Demographic	Frego Attrib Table	Percent Townhome SqFt per Net Acre	per_THAc	double	Duplicate	WeightedAverage	TOTSQFT
Residential Demographic	Frego Attrib Table	Percent Multifamily SqFt per Net Acre	per_MFAc	double	Duplicate	WeightedAverage	TOTSQFT
Residential Demographic	IXLandUseCanvas	Owner-Occupied Dwelling Unit Count	DwellingUnitCountOO	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	Residential Embodied CO2 (lbs/yr)	CO2EmbodiedRes	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	Residential Floor Area (sqft)	ResidentialFloorArea	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	Residential Operations Energy (MMBtu/yr)	EnergyOperationsRes	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	ResidentialPopulationMF	ResidentialPopulationMF	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	ResidentialPopulationOTH	ResidentialPopulationOTH	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	ResidentialPopulationSF	ResidentialPopulationSF	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	Student Count	StudentCount	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IXLandUseCanvas	Worker Count	WorkerCount	Double	GeomRatio	Sum	(n/a)
Residential Demographic	IX Indicator	Single-Family Housing Ownership (% sf DU owner-occupied)	Single-FamilyHousingOwnership	Double	Duplicate	WeightedAverage	SF
Residential Demographic	IX Indicator	Residential Footprint (net acres/1000 residents)	ResidentialFootprint	Double	Duplicate	WeightedAverage	POP
Residential Demographic	IX Indicator	Single-Family Parcel Size (avg square feet)	Single-FamilyParcelSize	Double	Duplicate	WeightedAverage	Acres
Residential Demographic	IX Indicator	Park/Schoolyard Supply (acres/1000 persons)	Park/SchoolyardSupply	Double	Duplicate	WeightedAverage	POP
Residential Demographic	IX Planned Land-Use	Employment Conformance	EmploymentConformance	Short Int	Duplicate	WeightedAverage	Acres
Residential Location	IX Indicator	Student Enrollment Level (% student capacity fulfilled)	StudentEnrollmentLevel	Double	Duplicate	WeightedAverage	StudentCount
Residential Location	IX Indicator	Amenities Adjacency (% pop w/i user buffer)	AmenitiesAdjacency	Double	Duplicate	WeightedAverage	POP
Residential Location	IX Indicator	Amenities Proximity (avg walk ft to closest)	AmenitiesProximity	Double	Duplicate	WeightedAverage	POP
Residential Location	IX Indicator	Transit Adjacency to Housing (% pop w/I user buffer)	TransitAdjacencytoHousing	Double	Duplicate	WeightedAverage	POP
Residential Location	IX Indicator	Transit Proximity to Housing (avg walk ft to closest)	TransitProximitytoHousing	Double	Duplicate	WeightedAverage	POP
Residential Location	IX Indicator	Key Feature Adjacency to Housing (% pop w/i user buffers)	KeyFeatureAdjacencytoHousing	Double	Duplicate	WeightedAverage	POP
Residential Location	IX Indicator	Park/Schoolyard Adjacency to Housing (% pop w/I user buffer)	Park/SchoolyardAdjacencytoHousing	Double	Duplicate	WeightedAverage	POP
Residential Location	IX Indicator	Park/Schoolyard Proximity to Housing (avg walk ft to closest)	Park/SchoolyardProximitytoHousing	Double	Duplicate	WeightedAverage	POP
Residential Location	IX School Attendance Areas	School Enrollment Capacity	EnrollmentCapacity	Long Int	Duplicate	WeightedAverage	Acres

CLASSIFICATION	ORIGIN	Attribute	Field Name	Field Type	Split Policy	HAM Policy	Weight
Travel	IX Indicator	Internal Street Connectivity (intersection/cul-de-sac ratio)	InternalStreetConnectivity	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	External Street Connectivity (avg ft between ingress/egress pts)	ExternalStreetConnectivity	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Street Segment Length (avg ft)	StreetSegmentLength	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Street Centerline Distance (total ft)	StreetCenterlineDistance	Double	GeomRatio	Sum	(n/a)
Travel	IX Indicator	Street Network Density (centerline mi/sq mi)	StreetNetworkDensity	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Street Network Extent (centerline miles/1000 residents)	StreetNetworkExtent	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Transit Service Coverage (stops/sq mi)	TransitServiceCoverage	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Transit Service Density (vehicle route mi/day/sqmi)	TransitServiceDensity	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Transit Orientation Index (unitless index of ridership potential)	TransitOrientationIndex	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Transit-Oriented Residential Density (DU/net acre w/i user buffer of stops)	Transit-OrientedResidentialDensity	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Transit-Oriented Employment Density (emps/net acre w/i user buffer of stops)	Transit-OrientedEmploymentDensity	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Light Rail Transit Boardings (avg persons/day)	LightRailTransitBoardings	Double	GeomRatio	Sum	(n/a)
Travel	IX Indicator	Heavy Rail Mode Shift (avg daily VT/capita shifted)	HeavyRailModeShift	Double	GeomRatio	Sum	(n/a)
Travel	IX Indicator	Pedestrian Network Coverage (% of streets w/sidewalks)	PedestrianNetworkCoverage	Double	Duplicate	WeightedAverage	Length
Travel	IX Indicator	Pedestrian Crossing Distance (avg curb-to-curb ft)	PedestrianCrossingDistance	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Pedestrian Intersection Safety (% intersections w/traffic controls)	PedestrianIntersectionSafety	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Street Route Directness (walk distance/straightline ratio)	StreetRouteDirectness	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Pedestrian Setback (avg commercial bldg setback ft)	PedestrianSetback	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Pedestrian Accessibilities (% origins w/i 15 min walk of destinations)	PedestrianAccessibilities	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Bicycle Network Coverage (% street centerlines w/i bike route)	BicycleNetworkCoverage	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Residential Multi-Modal Access (%DU w/3+ modes w/i 1/8 mi)	ResidentialMulti-ModalAccess	Double	Duplicate	WeightedAverage	Acres
Travel	IX Indicator	Vehicle Miles Traveled (mi/day/capita)	VehicleMilesTraveled	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Vehicle Trips (trips/day/capita)	VehicleTrips	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Home Based VMT Produced (mi/day/capita)	HomeBasedVMTProduced	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Non-Home Based VMT Attracted (mi/day/emp)	Non-HomeBasedVMTAttracted	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Home Based VT Produced (trips/day/capita)	HomeBasedVTProduced	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Non-Home Based VT Attracted (trips/day/emp)	Non-HomeBasedVTAttracted	Double	Duplicate	WeightedAverage	EMP
Travel	IX Indicator	Parking Lot Size (lot acres/1000 residents)	ParkingLotSize	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Parking Requirements (total spaces required)	ParkingRequirements	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Residential Vehicle Energy Use (MMBtu/yr/capita)	ResidentialVehicleEnergyUse	Double	Duplicate	WeightedAverage	POP
Travel	IX Indicator	Non-Home Based Vehicle Energy Use (MMBtu/yr/emp)	Non-HomeBasedVehicleEnergyUse	Double	Duplicate	WeightedAverage	EMP
Travel	IX Indicator	Residential Vehicle CO2 Emissions (lbs/capita/yr)	ResidentialVehicleCO2Emissions	Double	Duplicate	WeightedAverage	POP

CLASSIFICATION	ORIGIN	Attribute	Field Name	Field Type	Split Policy	HAM Policy	Weight
Travel	IX Indicator	Non-Home Based Vehicle CO2 Emissions (lbs/emp/yr)	Non-HomeBasedVehicleCO2Emissions	Double	Duplicate	WeightedAverage	EMP
Travel	IX Street Centerlines	Right-of-Way Width (ft.)	RightOfWayWidth	Double	Duplicate	WeightedAverage	Length
Travel	IX Street Centerlines	Percent of Segment with Sidewalks	SidewalkPercent	Double	Duplicate	WeightedAverage	Length
Travel	IX Street Centerlines	Sidewalk Width (ft.)	SidewalkWidth	Double	Duplicate	WeightedAverage	Length
Travel	IX Street Centerlines	Street Width (ft.)	StreetWidth	Double	Duplicate	WeightedAverage	Length
Travel	IX Transit Routes	Transit Group (subtype)	TransitGroupID	Long Int	Duplicate	WeightedAverage	Acres
Travel	IX Transit Routes	Right-of-Way Width	RightOfWayWidth	Double	Duplicate	WeightedAverage	Acres
Travel	IX Transit Routes	Route Segment Traffic (vehicles/day)	VehicleCount	Long Int	Duplicate	WeightedAverage	Acres
Travel	IX Transit Stops	Transit Group (subtype)	TransitGroupID	Long Int	Duplicate	DominantValue	Count
Travel	IX Transit Stops	Does the Stop Offer Parking	HasParking	Short Int	Duplicate	DominantValue	Count
Travel	IX Transit Stops	Is the Stop a Terminus	IsTerminus	Short Int	Duplicate	DominantValue	Count
Travel	IX Transit Stops	Commuter Stop (Peak Hour Service Only)	PeakHourServiceOnly	Short Int	Duplicate	DominantValue	Count

Glossary

MGB (Maximum Geographic Boundary): a polygon defining the limit of all possible analysis in a SPARC implementation. All data imported into the warehouse is trimmed by this layer.

DQIS (INDEX Data Quality and Interoperability Service): a client application designed to support the uploading of data from a user's desktop to the SPARC warehouse.

CATS (Capital Area Texas Sustainability): a Consortium contracting the SPARC project.

TACC (Texas Advanced Computing Center): Cloud provider for initial SPARC warehouse and DQIS application implementation.

PGLT (Primary Geometry Layer Type): one of the fixed set of possible unique geometry layers which both describe some aspect of the built or natural environment and are deemed useful to scenario planning analysis.

FieldDef (PGLT Field Definition): A destination for attribute data sourced in a shapefile DBF, these objects are shareable/re-useable across many layers containing the same type of data.

PB (Planning Boundary): a polygon, delimiting a jurisdictional or governmental boundary, which could define a study area for indicator calculation.

PFA (Policy Focus Area): a polygon that derives from another (PGLT or other) feature but is included in a scenario to influence its design rather than be used in indicator calculation.

LUC (Land Use Canvas): a grouping of PGLTs that are distinguished from Planning Boundaries by their having an associated land-use classification attribute. These layers are often the source of a land-use planning scenario.

TNW (Transportation Network): a PGLT line/point feature that characterizes the routes by which one or several modes travel from an origin to a destination.

VIZ (3D or other visualization): Placeholder PGLTs which can support the storage of 3D or other visualization objects inside the database, as well as procedural rules for dyanamic generation of 3D models.

ENV (Environmental): PGLTs describing environmental features.

IFR (Infrastructure): PGLTs describing infrastructure features.

HAM (Hierarchical Aggregation Model): a proposed future enhancement that would automatically propagate parcel-level scenario design and indicator results upwards into Planning Boundary PGLT layers. Described in the DQIS specification's Roadmap section.