

# ESRI Data Modeling for Petroleum

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(Peter Boorman)

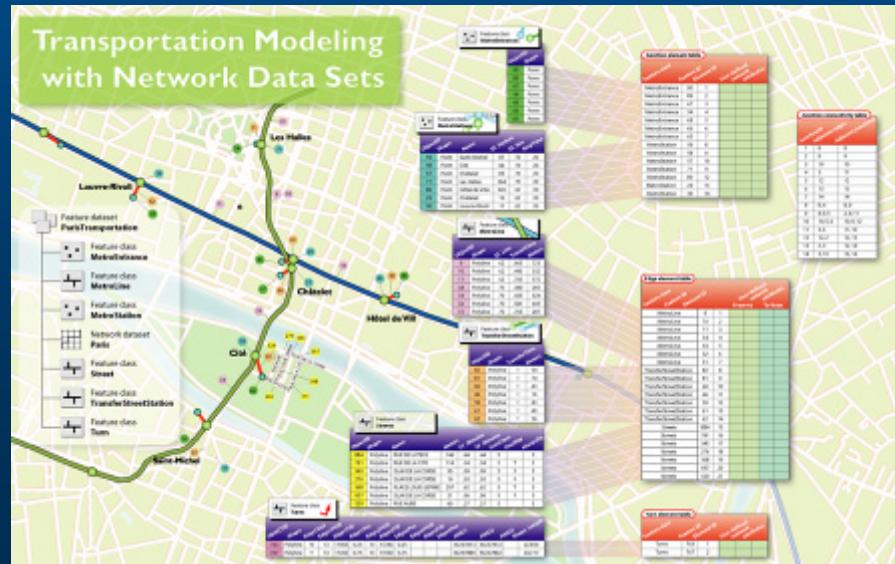
# Overview

- Topics
  - Data model concepts with focus on Petroleum
  - Basic data model implementations
  - 3D applications specific to petroleum
- Goals
  - Review corporate data holdings
  - Get you started with ESRI data modeling for petroleum
  - Review and define specific elements of the PPDM data model

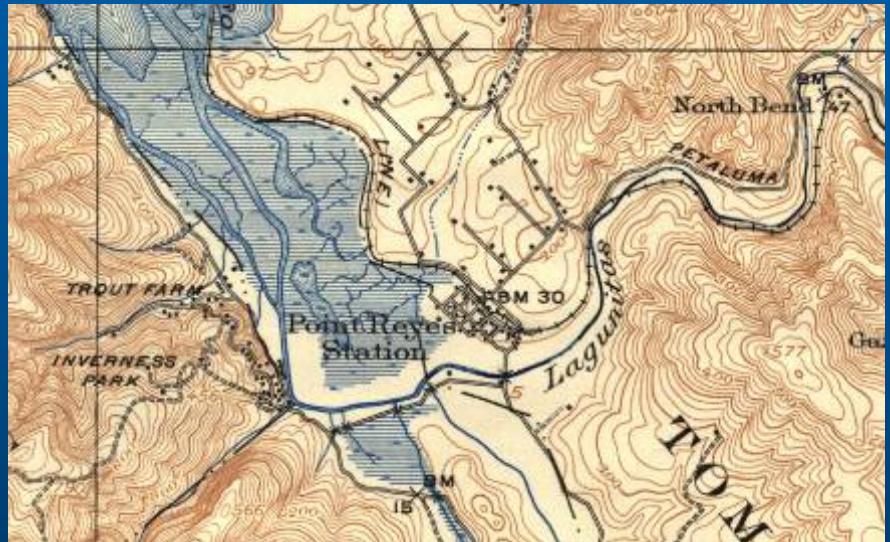
# Models and reality



# A map is a scale model of geographic reality

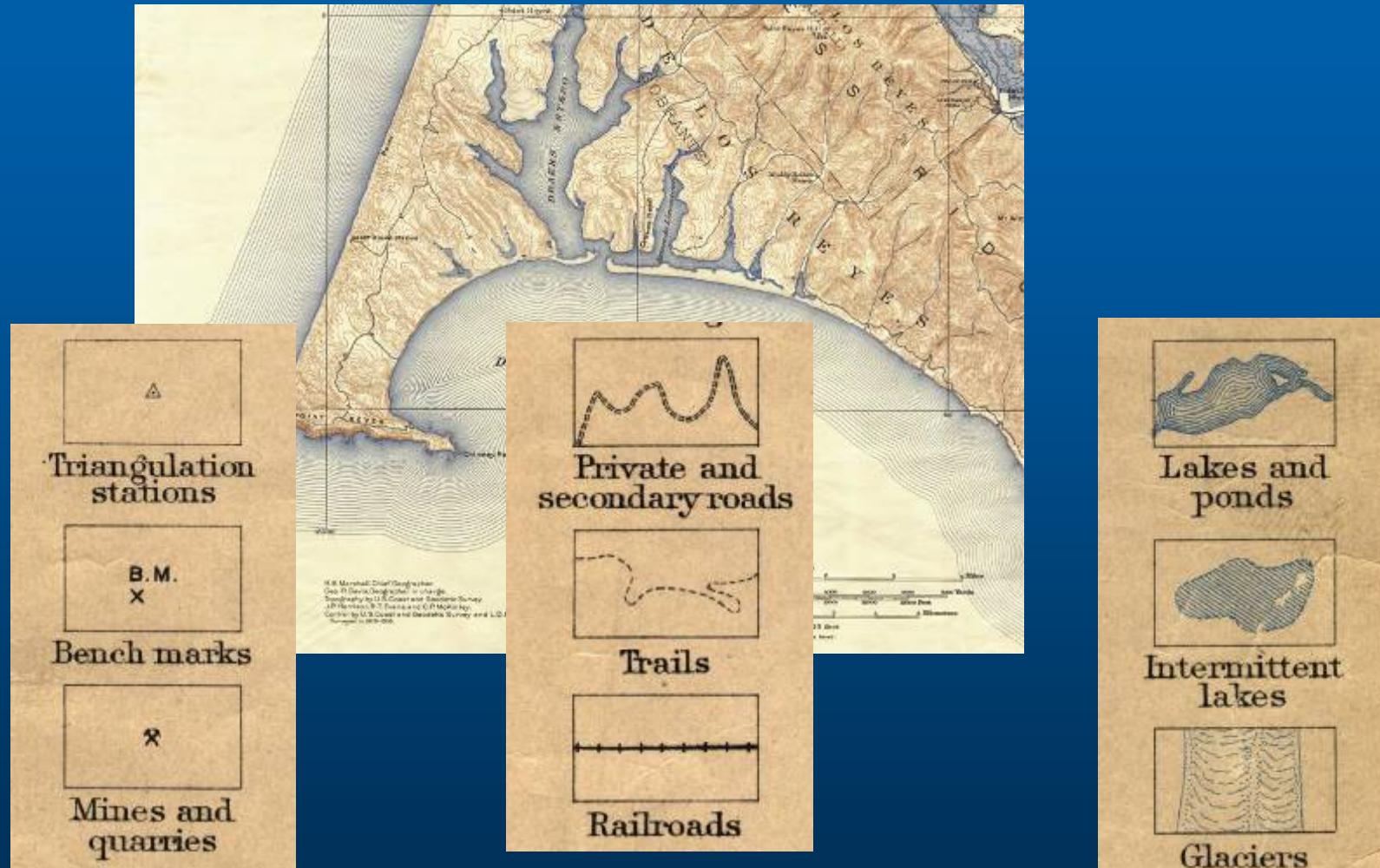


**A model is a representation of a system  
on which simulations are run from  
inputs and predictions are made**



**A GIS data model is a set of representation objects, such as points, lines, polygons, and rasters, capturing the behavior of a system, such as network flow.**

# Map features drawn as points, lines, and areas

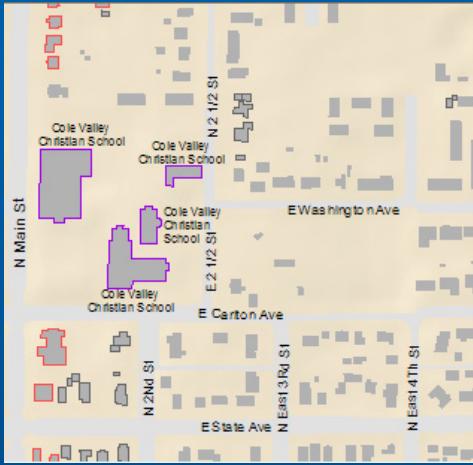


Small objects are drawn as points

Objects long but not wide are drawn as lines

Objects with extent are drawn as areas

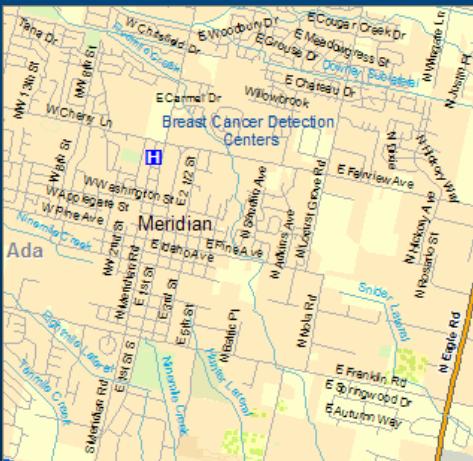
# Map scale determines representation



**1 : 5,000**  
**Buildings are polygons**  
**Roads drawn by curb lines**  
**All road names are labeled**



**1 : 25,000**  
**Only prominent buildings drawn**  
**Roads drawn by centerlines**  
**Selective labeling of roads**

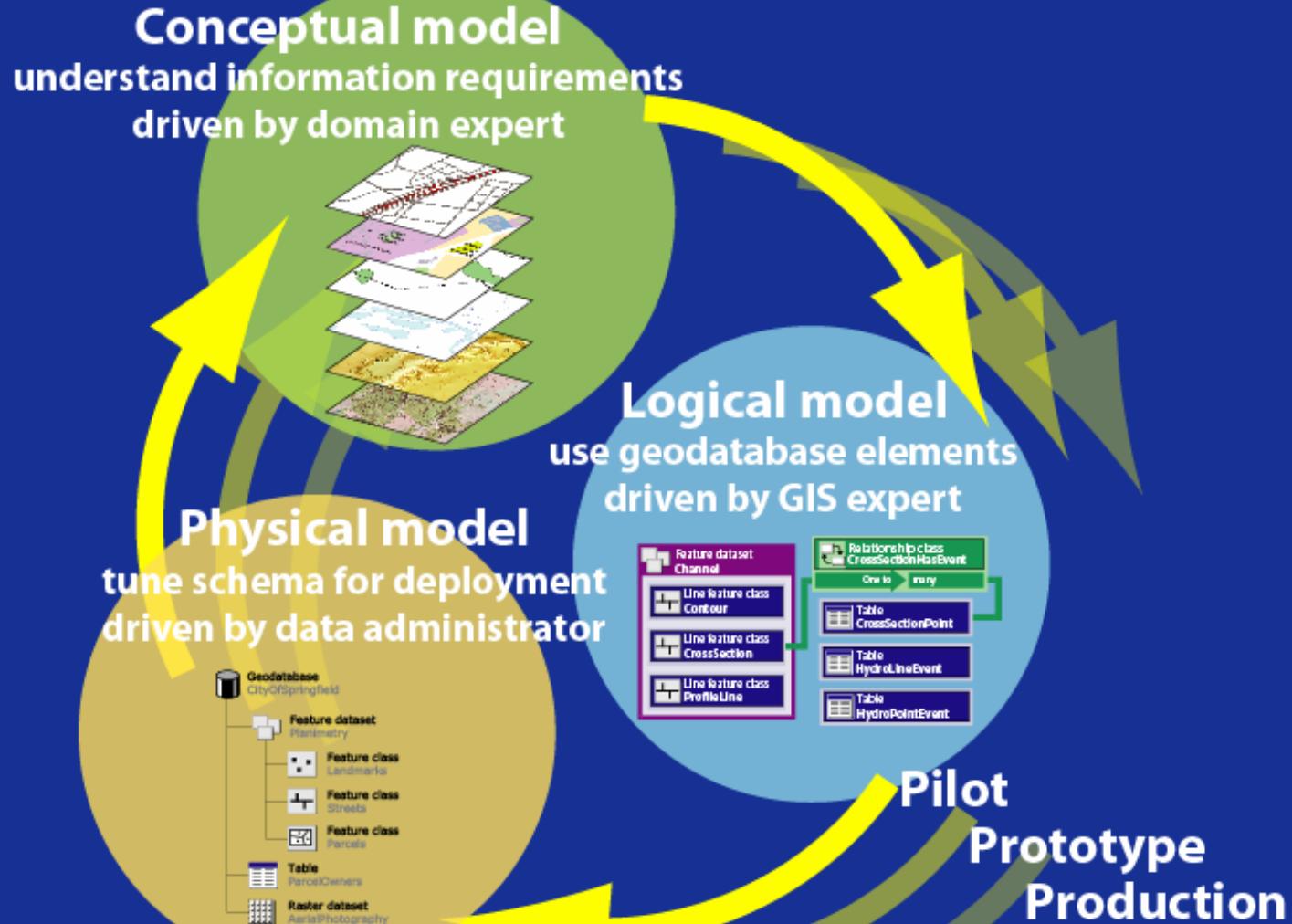


**1 : 50,000**  
**Important buildings drawn as landmark symbols and labels**  
**Minor roads filtered out**

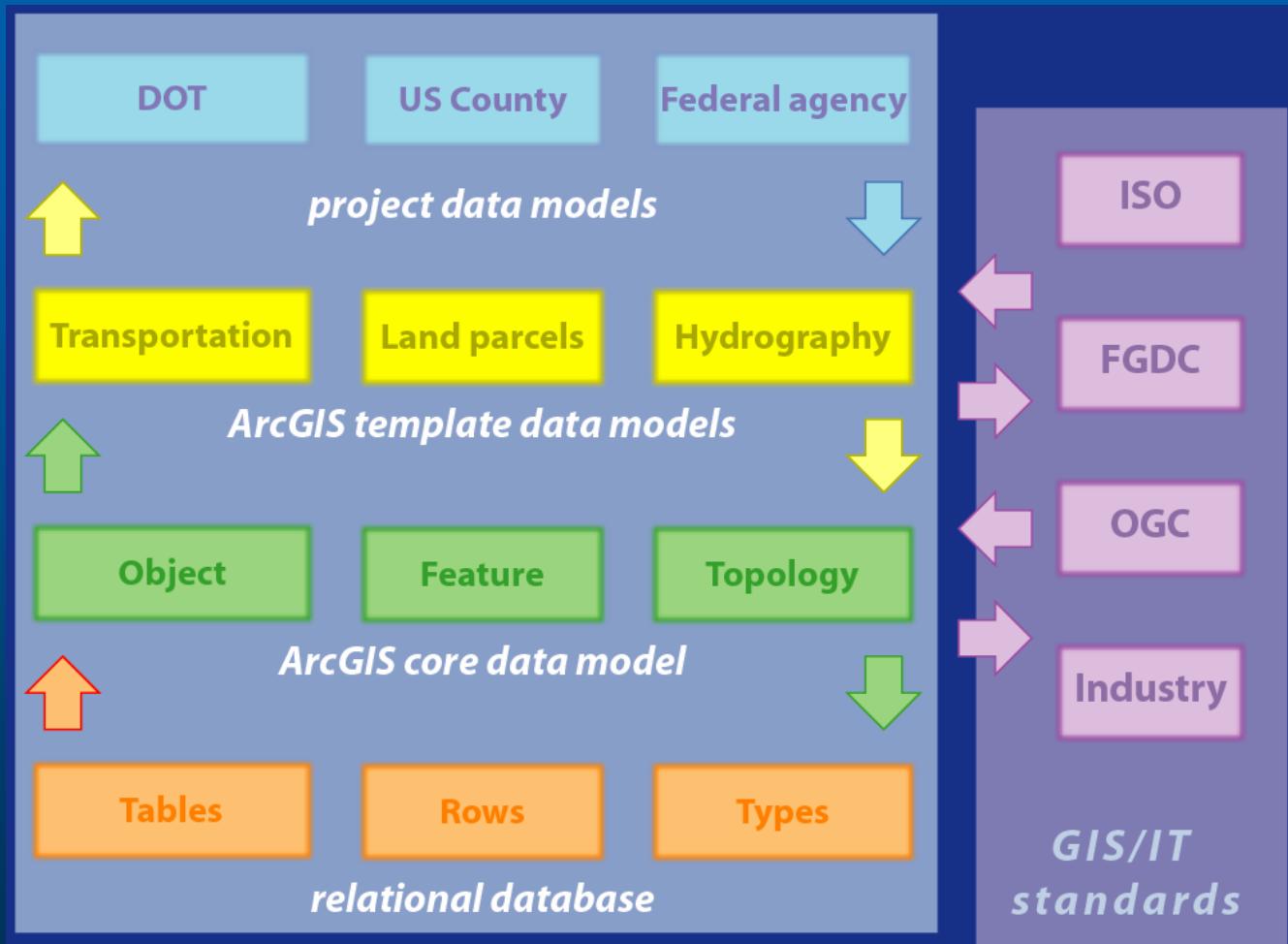


**1 : 250,000**  
**Built areas become aggregated into polygons**  
**Only major roads displayed**  
**Key places labeled**

# The Data Modeling Cycle



# Levels of data models



# Data Models that ESRI Produces

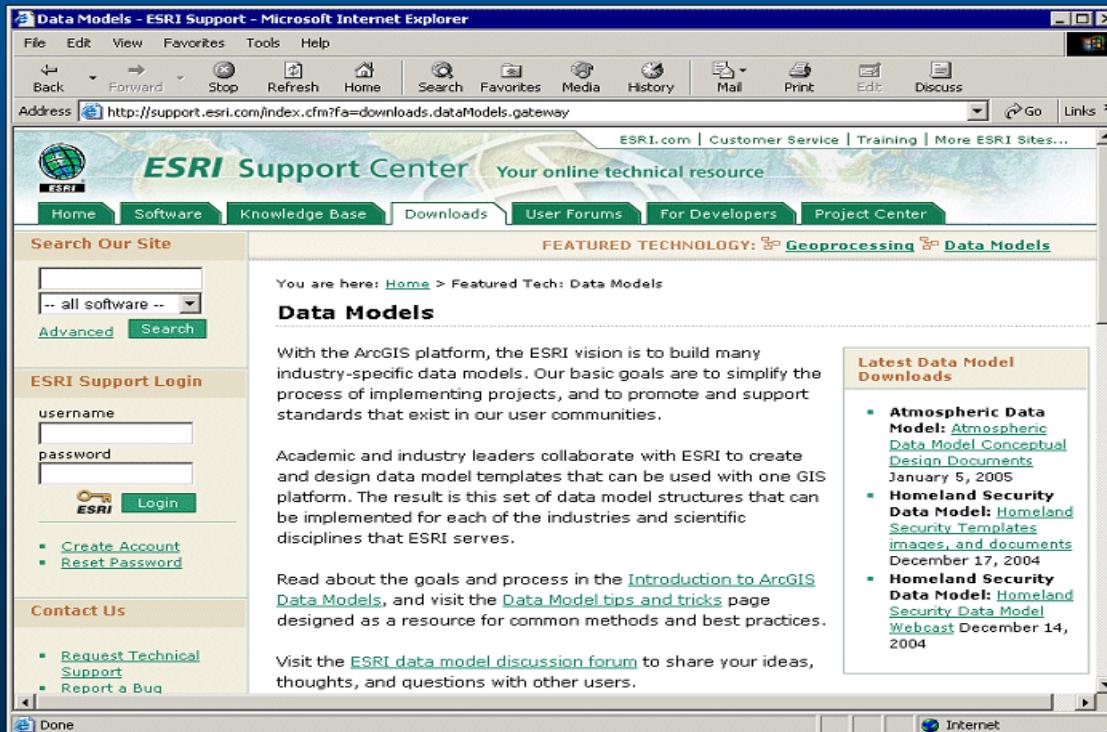
*Created and owned by user groups and industries*



# ArcGIS Data Models Web site

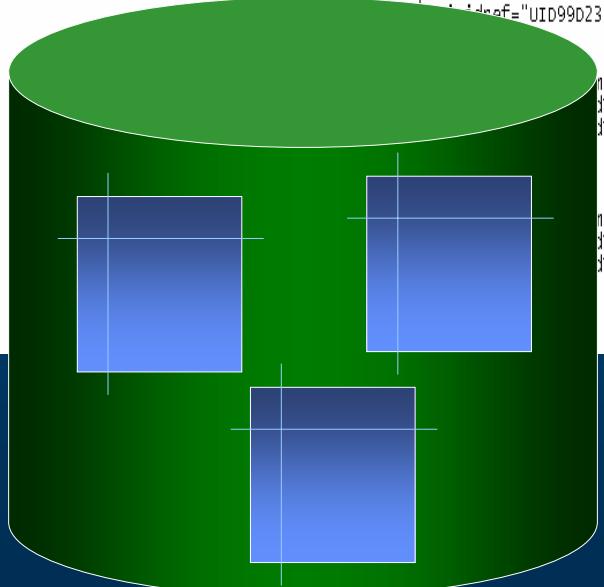
<http://support.esri.com/datamodels>

- Over 25 industry-specific data models
- Conceptual and logical diagrams
- Case studies, Tips and Tricks documents



# What is Schema?

```
<xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE XMI SYSTEM "uml.dtd">
<XMI xmi.version="1.0">
  <XMI.header>
    <XMI.documentation>
      <XMI.exporter>Microsoft Visio</XMI.exporter>
      <XMI.exporterVersion>1.0</XMI.exporterVersion>
    </XMI.documentation>
    <XMI.metamodel xmi.name="UML" xmi.version="1.1"/>
  </XMI.header>
  <XMI.content>
    <Model_Management.Subsystem xmi.id="UID99D23D90-519E-11D3-9F81-00C04F6BDF1A">
      <Foundation.Core.ModelElement.name>ArcGIS Parcel Data Model_06-09-03</Foundation.Core.ModelElement.name>
      <Foundation.Core.ModelElement.visibility xmi.value="public"/>
      <Foundation.Core.GeneralizableElement.isRoot xmi.value="false"/>
      <Foundation.Core.GeneralizableElement.isLeaf xmi.value="false"/>
      <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
      <Model_Management.Subsystem.isInstantiable xmi.value="false"/>
      <Foundation.Core.ModelElement.stereotype>
        <Foundation.Extension_Mechanisms.Stereotype xmi.idref="UIDCB8C80-519E-11D3-9F81-00C04F6BDF1A">
          <Foundation.Core.ModelElement.name>Parcel Data Model</Foundation.Core.ModelElement.name>
          <Foundation.Core.ModelElement.visibility xmi.value="public"/>
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          <Foundation.Core.GeneralizableElement.isLeaf xmi.value="false"/>
          <Foundation.Core.GeneralizableElement.isAbstract xmi.value="false"/>
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        </Foundation.Extension_Mechanisms.Stereotype>
      </Foundation.Core.ModelElement.stereotype>
      <Foundation.Core.ModelElement.namespace>
        <Foundation.Core.Namespace.xmi.id>UID99D23D90-519E-11D3-9F81-00C04F6BDF1A</Foundation.Core.Namespace.xmi.id>
        <Foundation.Core.Namespace.name>ArcGIS Parcel Data Model</Foundation.Core.Namespace.name>
        <Foundation.Core.Namespace.visibility xmi.value="public"/>
      </Foundation.Core.ModelElement.namespace>
    </Model_Management.Subsystem>
  </XMI.content>
</XMI>
```



- In the GIS it is a list of the names of contents and rules stored in the Geodatabase.
- Organized approach of grouping knowledge.
- The concepts and actions that can be revised and used to create a database.

# Topics

- Spatial in context
- What is PPDM Spatial
- Value of Spatial to our industry
- Incorporating Spatial into existing and new business processes

# Spatial in context

Text	Date	Geometry	Field type
Oil	03 27 95		

- Storing geometry with attributes in a database
- Spatial Index
- Storing behavior
  - sub-types
  - domain control (reference tables)
  - geometry rules

# Spatial store methods

**ESRI  
ArcSDE**

**Binary Schema -  
BLOB or Long Raw**

**Oracle  
Spatial**

**Geometry Type -  
SDO\_Geometry**

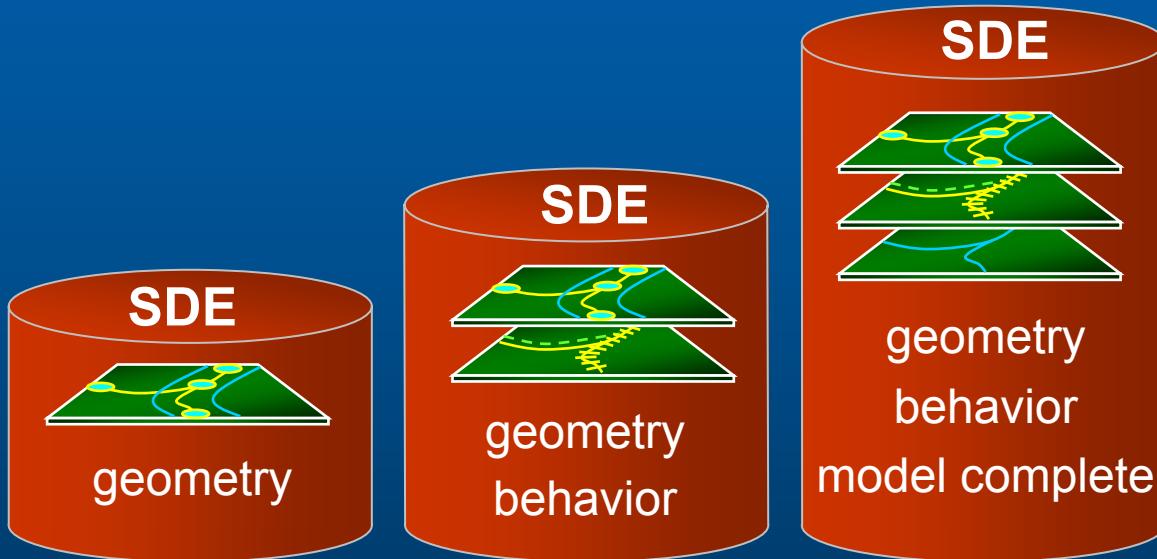
# The Geodatabase

ArcSDE Geodatabase  
Oracle



Personal Geodatabase  
Microsoft Jet Engine

# Industry Transition



# Benefits of Spatial

## Improved Data Management

Connectivity

85% Oil and Gas  
Is spatial



SHARED!

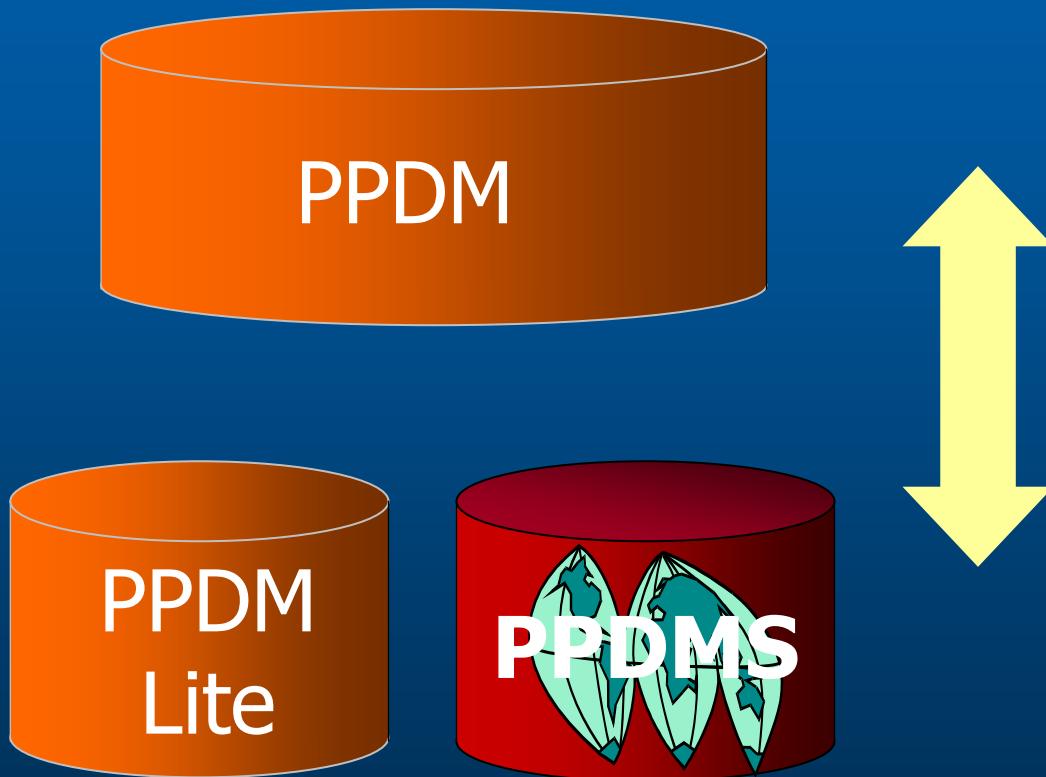
Master store

Spatial Analysis

Seamless

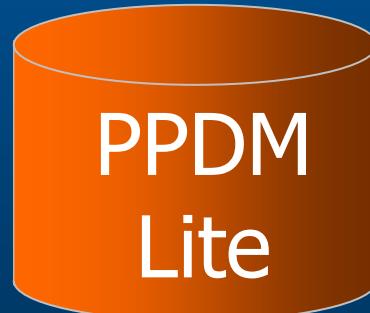
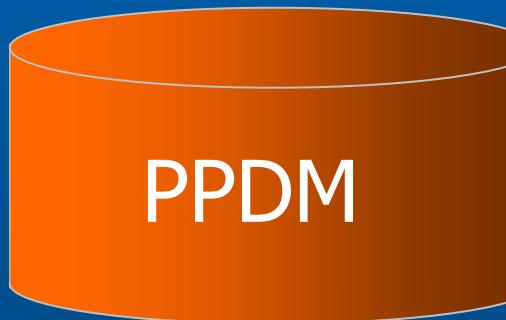
Advanced Business Applications

# PPDM Spatial



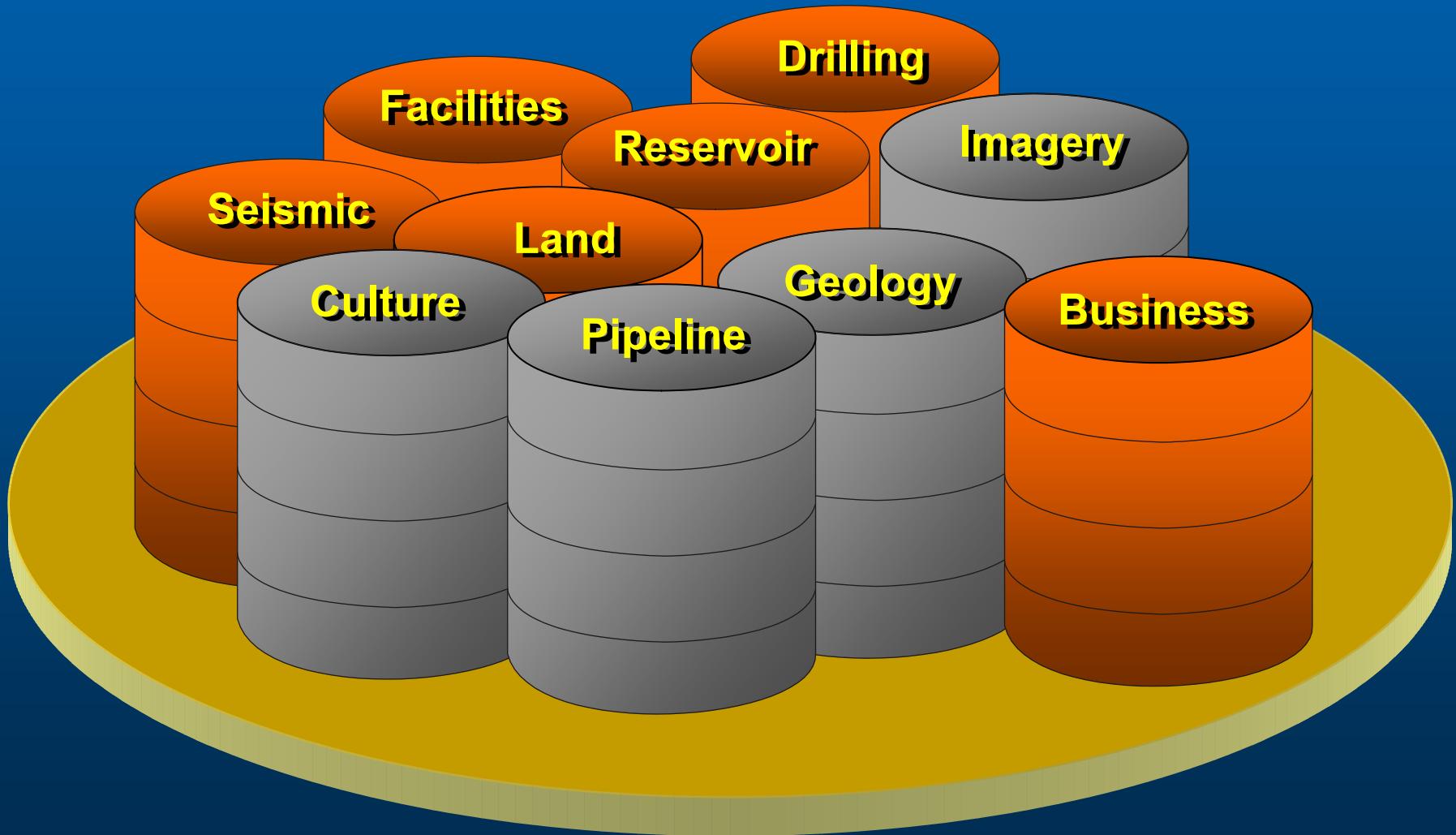
# PPDM Spatial

PPDM Spatial



Culture  
Geology  
Environment  
Pipeline  
Imagery  
Forestry

# Digital Earth Model



# Considerations

## Technical

Spatial as a component of the corporate technical backbone

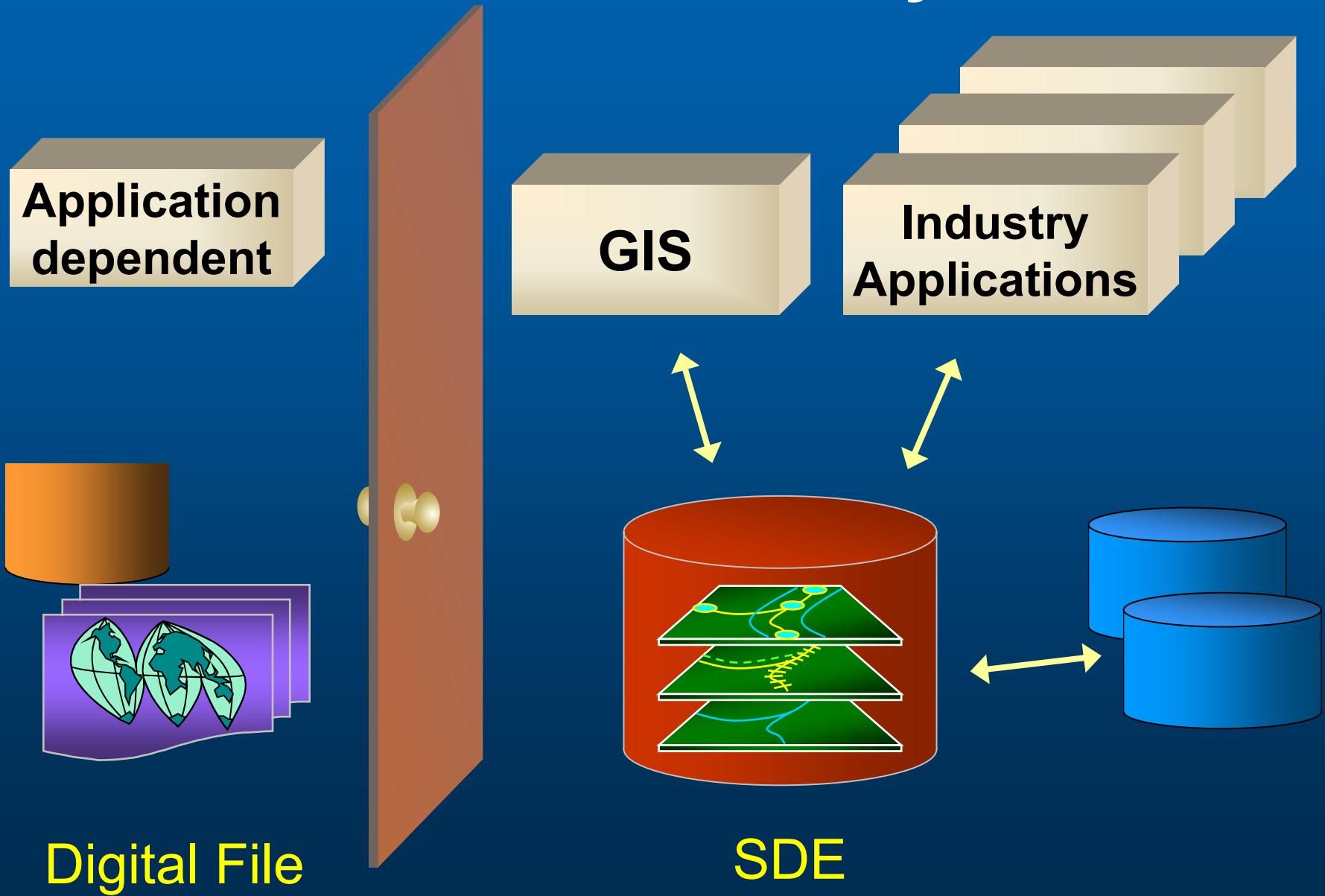
## People

GIS specialists and spatial data managers incorporated within the business unit and support framework

## Process

Procedures defined and implemented to enable the new architecture

# SDE connectivity



# Shared application use

Wood Mackenzie Pathfinder

GeoQuest Smartview

Petrosys

Trango

Web GIS

IHS

GIS

Landmark  
PowerExplorer

More coming !



# SDE hubs (data vendors, bps)

IHS Canada

IHS International

Partners



GIS  
Web GIS

Wood Mackenzie

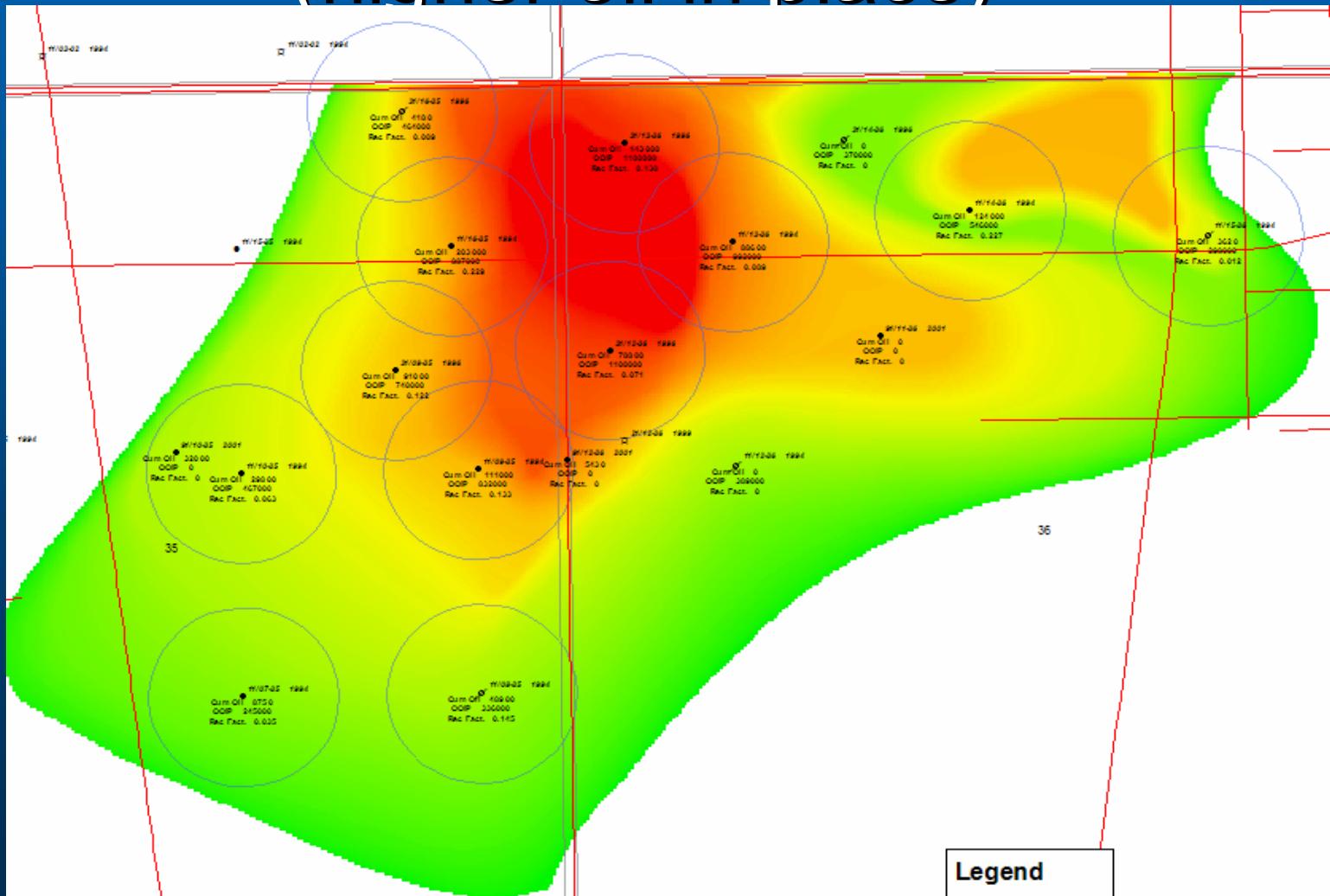
# New processes –not typically available in the standalone database

- Spatial query and analysis
- Data management and validation
- Storing remote Sensing data
- Technical Information Library
- 2D / 3D visualization

# Spatial query

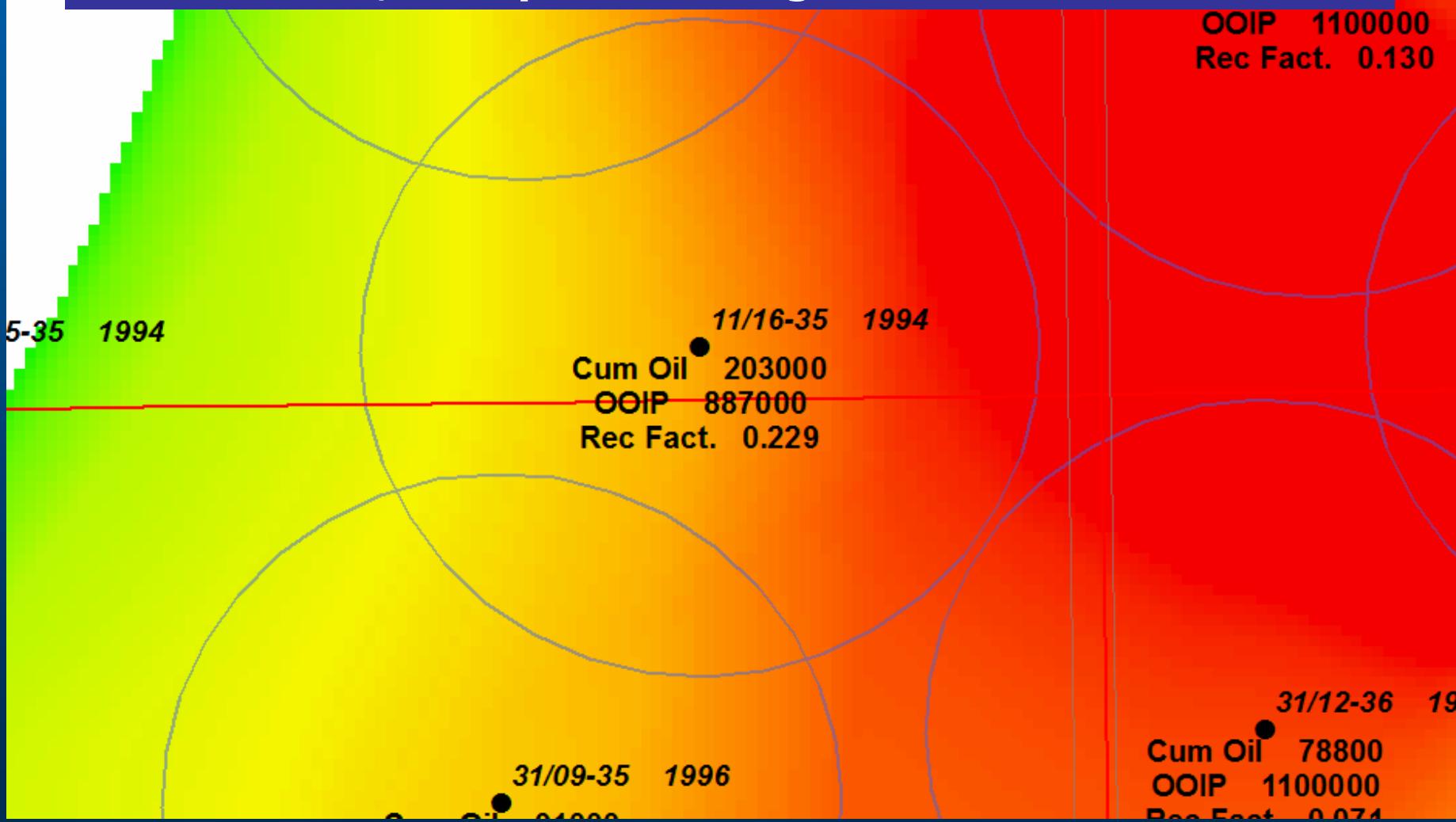
- Determine the daily production for all wells connected to a specific pipeline within a specific township range
- Determine the average reserves for all pools wholly or partially within a specific lease
- Others?

# Spatial Analysis Recovery factor (higher oil in place)



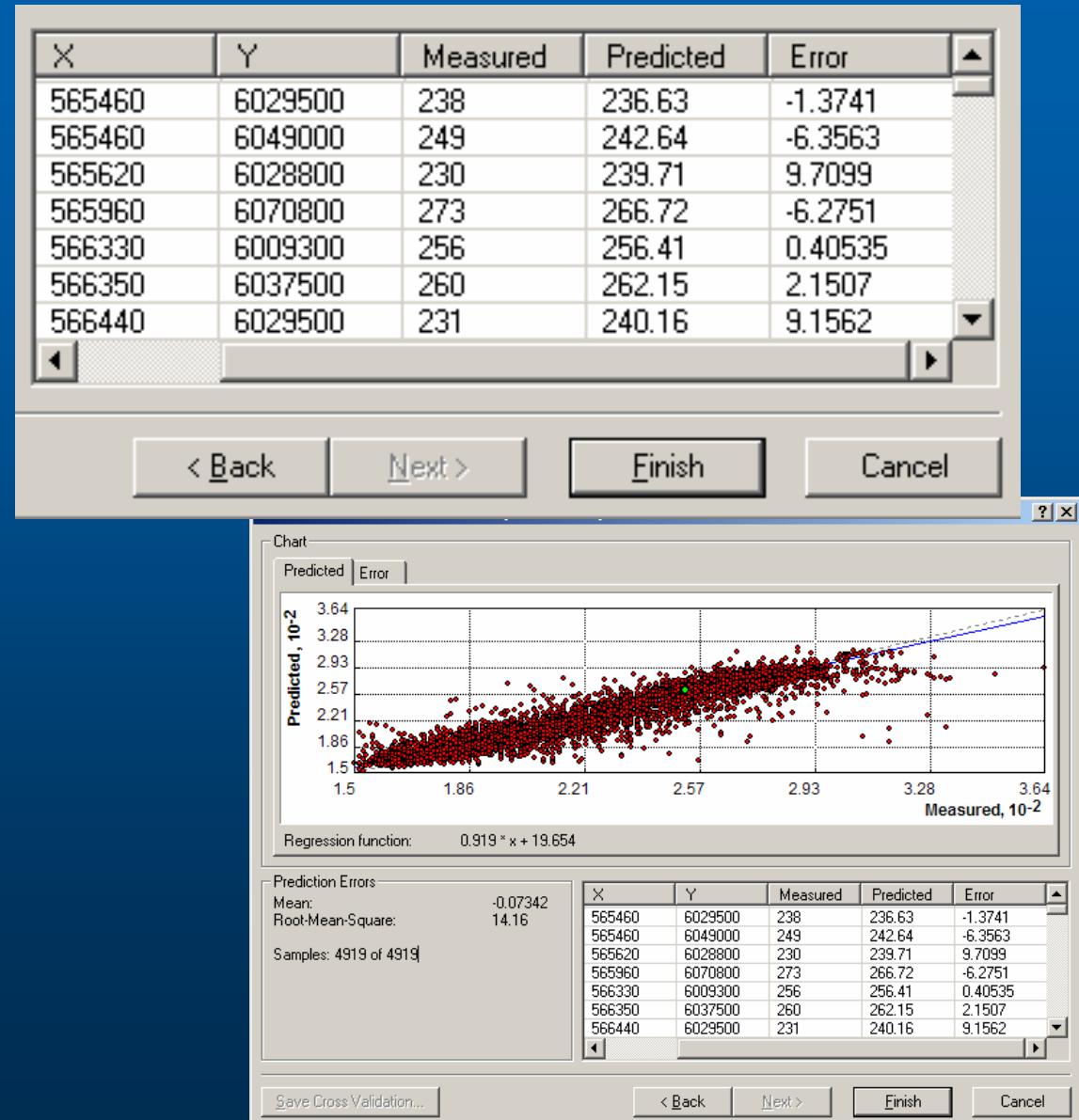
**Step one - Original Oil in place calculation using the raster calculator. Inputs are oil pay, water saturation, and porosity**

**Step two - Recovery factor determined from oil in place, cumulative oil, and spatial drainage area.**

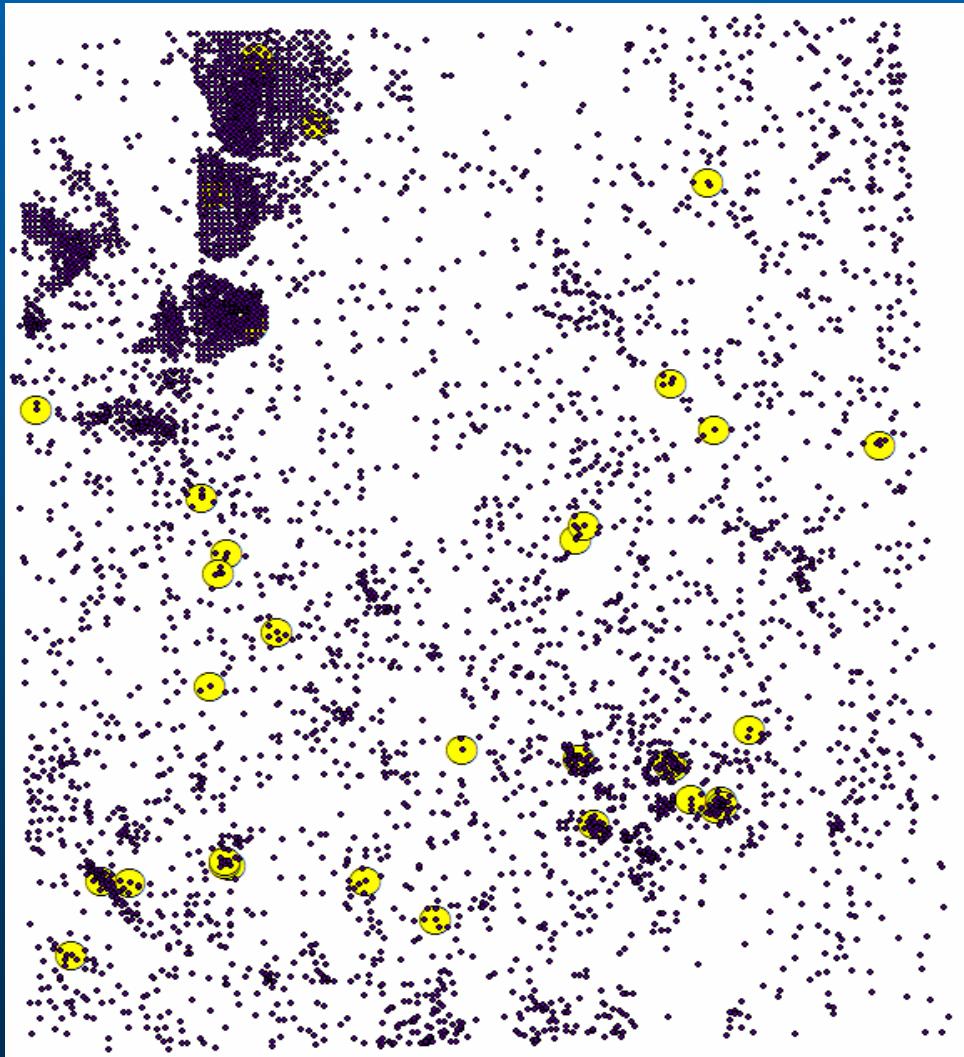


# Spatial interpolation

- Predict value for each point

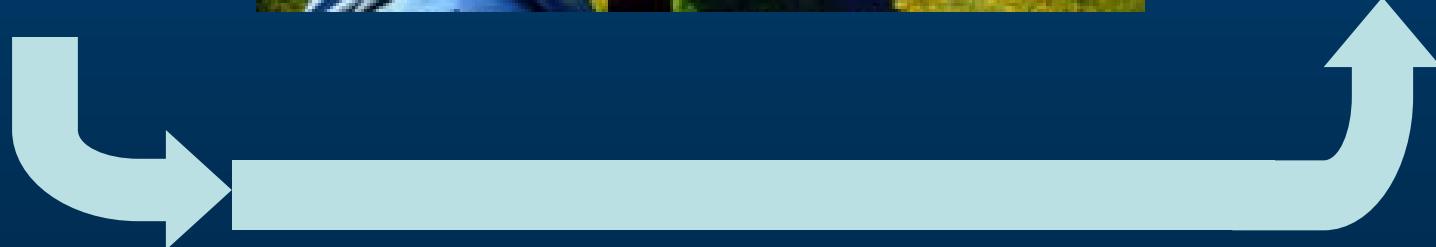


# Compare predicted to published

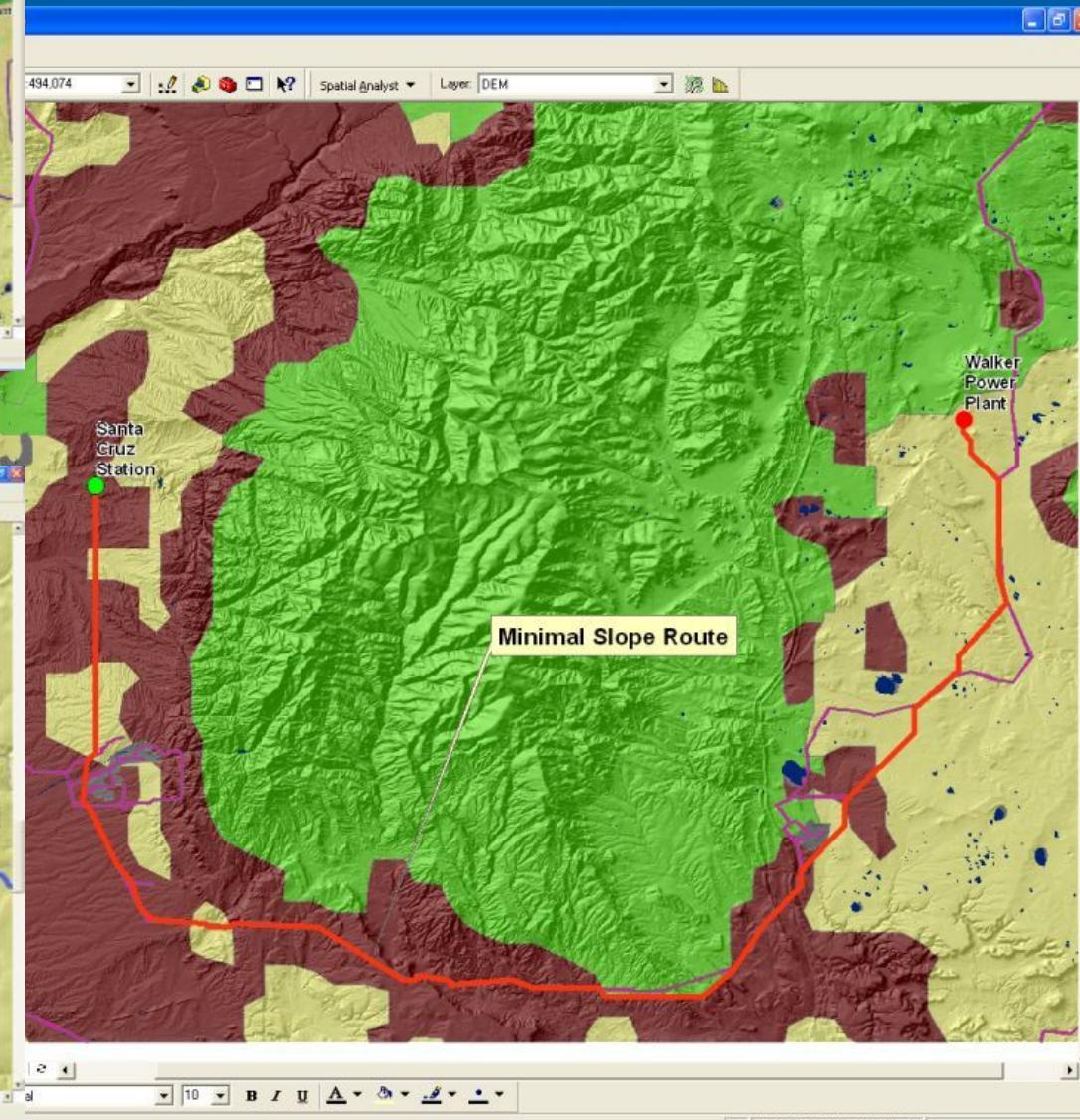
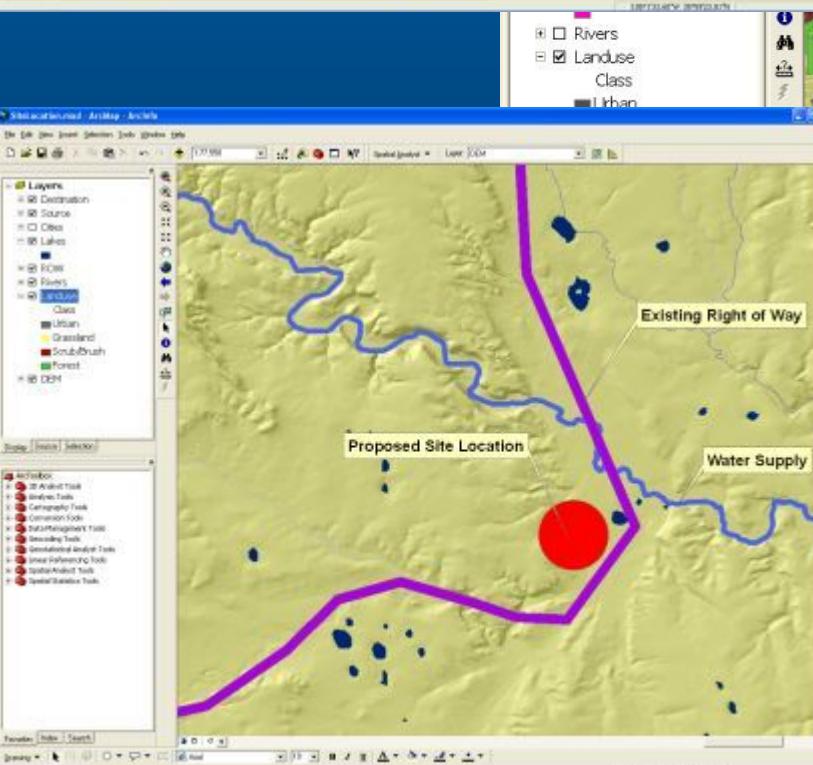
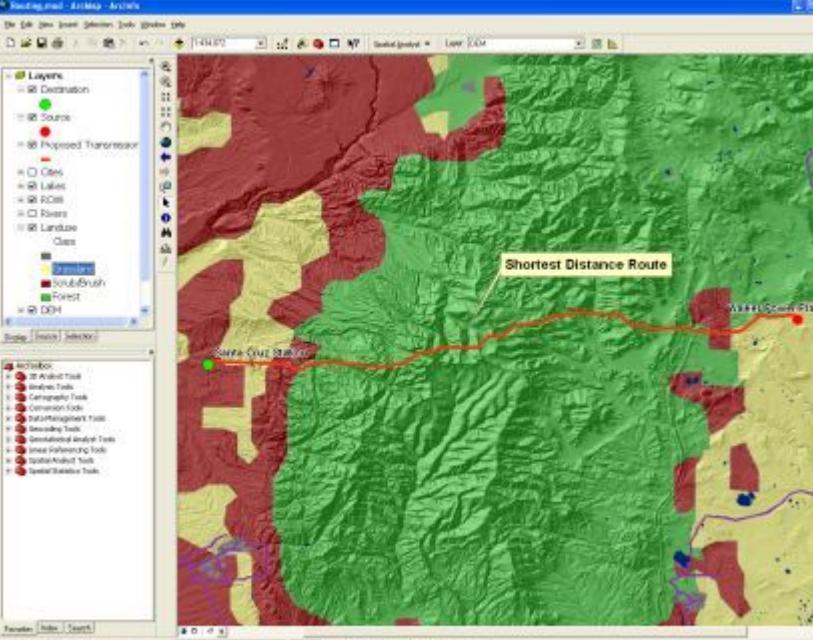


- Look at all errors say  $> -50$
- Yellow are wells that production did not meet expectations
- Engineering calculations in a spatial context

# Pipeline routing



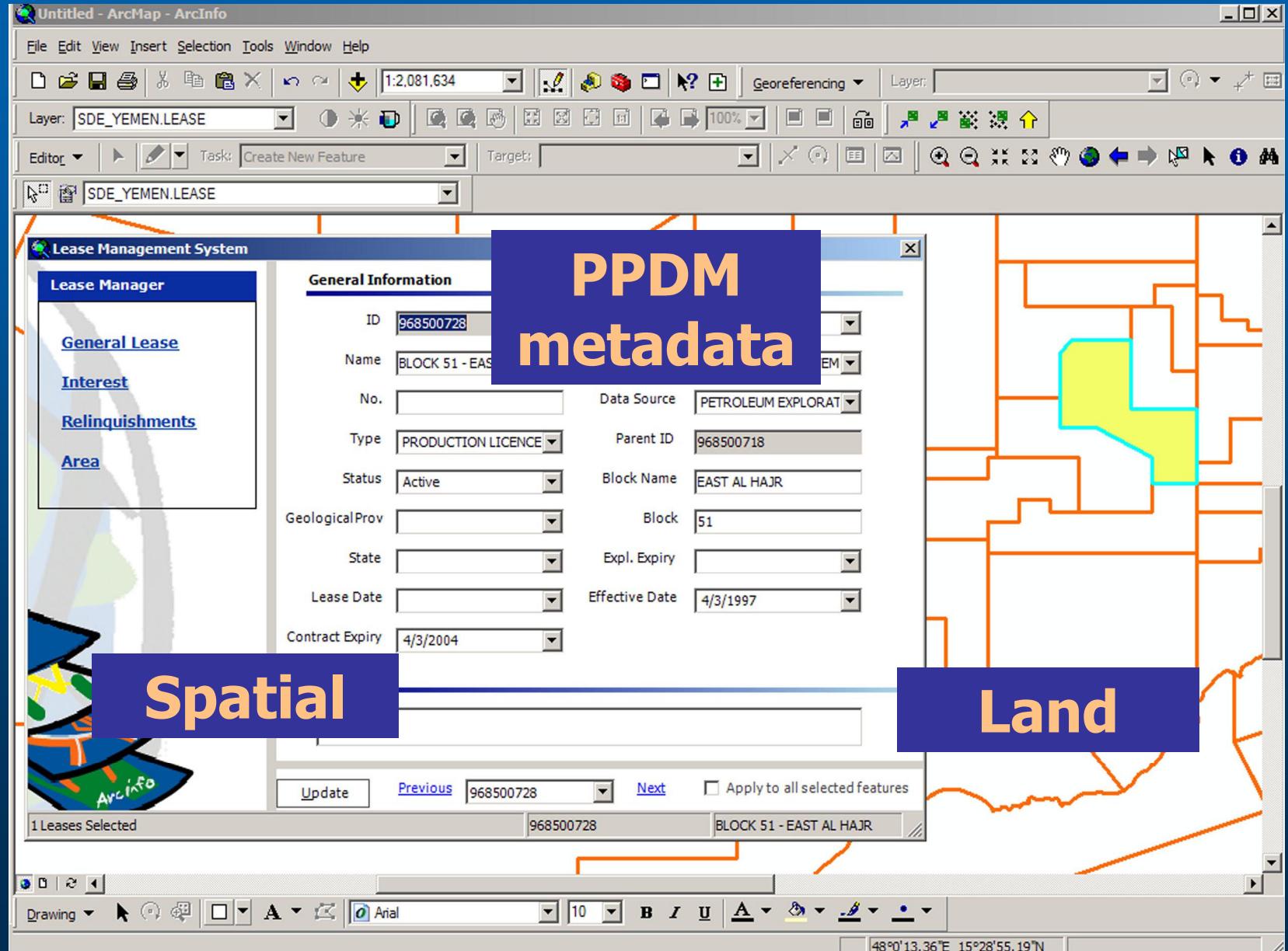
# Pipeline Routing



# Incorporate data edits through PPDM Spatial transactions

- Manage data with relationship to object in SDE
- Apply attributes based on spatial data selection
- Validate using spatial analysis
- Apply geodetic shifts etc.
- Apply topology rules
- Apply behaviors

# Nexen PPDM Land data



# Store Remote Sensing data – the raster catalog –

- Master data store with complete metadata
- Images indexed and compressed
- Distribution through SDE
- RS data growing at an exponential rate

# Technical Information Library

## DECISION HISTORY

Date	Issue	Decision	Signed-off
May 21 1991	Farm-out Pinto well	Offers to Esso	Larry Redman

Access to any application.

## FINANCIAL SUMMARY

Year	G&A	Capital	Total	To date	Balance
1995	\$100	\$200	\$300	\$272	\$28
Year	SAFE	AFE description	Actual		
1995	\$20	Drill Pinto 5	\$18		

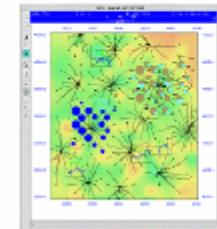
Access to any application.

## KNOWLEDGE

Project activity	Author	Results	Comments
Porosity study	Jan White	Bello Frn. info.	Good flow characteristics.



Database, or  
File, or  
Mindshare



Access to any application.

## PERSONNEL

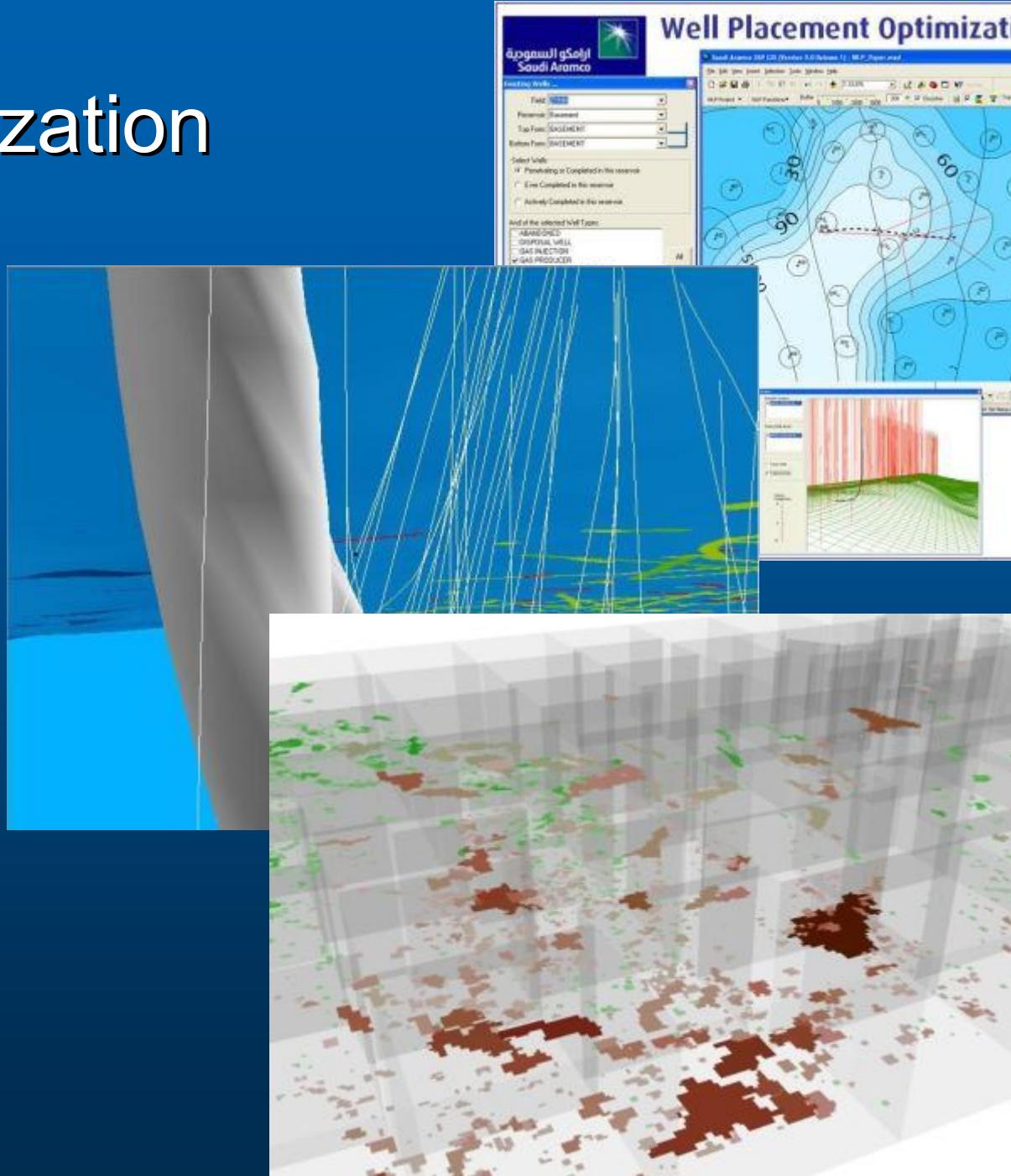
Personnel	Role	Date Start	Date Finish	Activity summary
Bill Brown	Geologist	June 1992	June 1995	Exploration on Pasto block.

Access to any application.

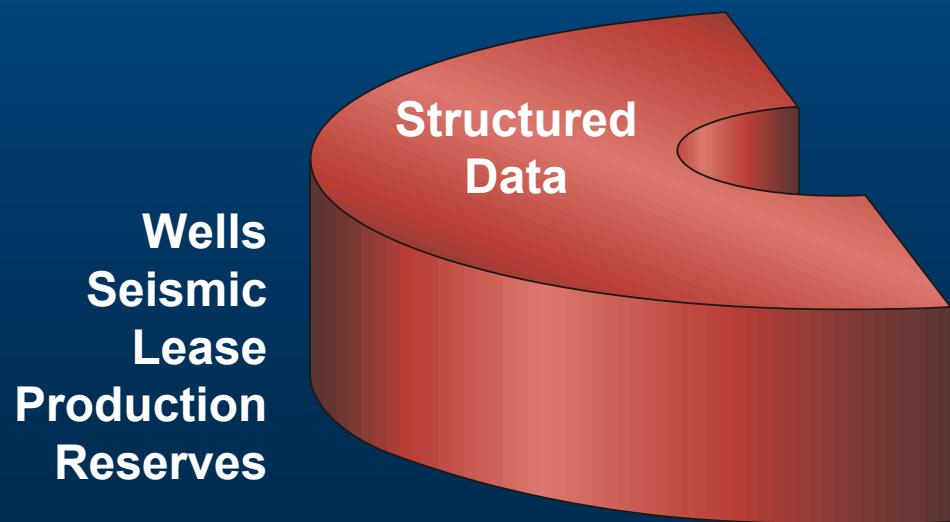
# Visualization

# 3D Visualization

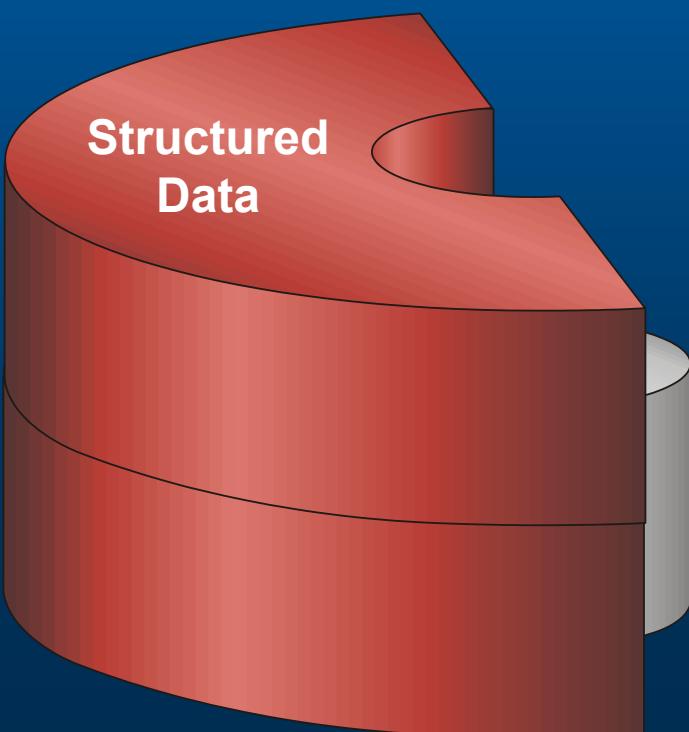
- 3D display
- Grids
- Wellbores
- Etc.



# Building Blocks



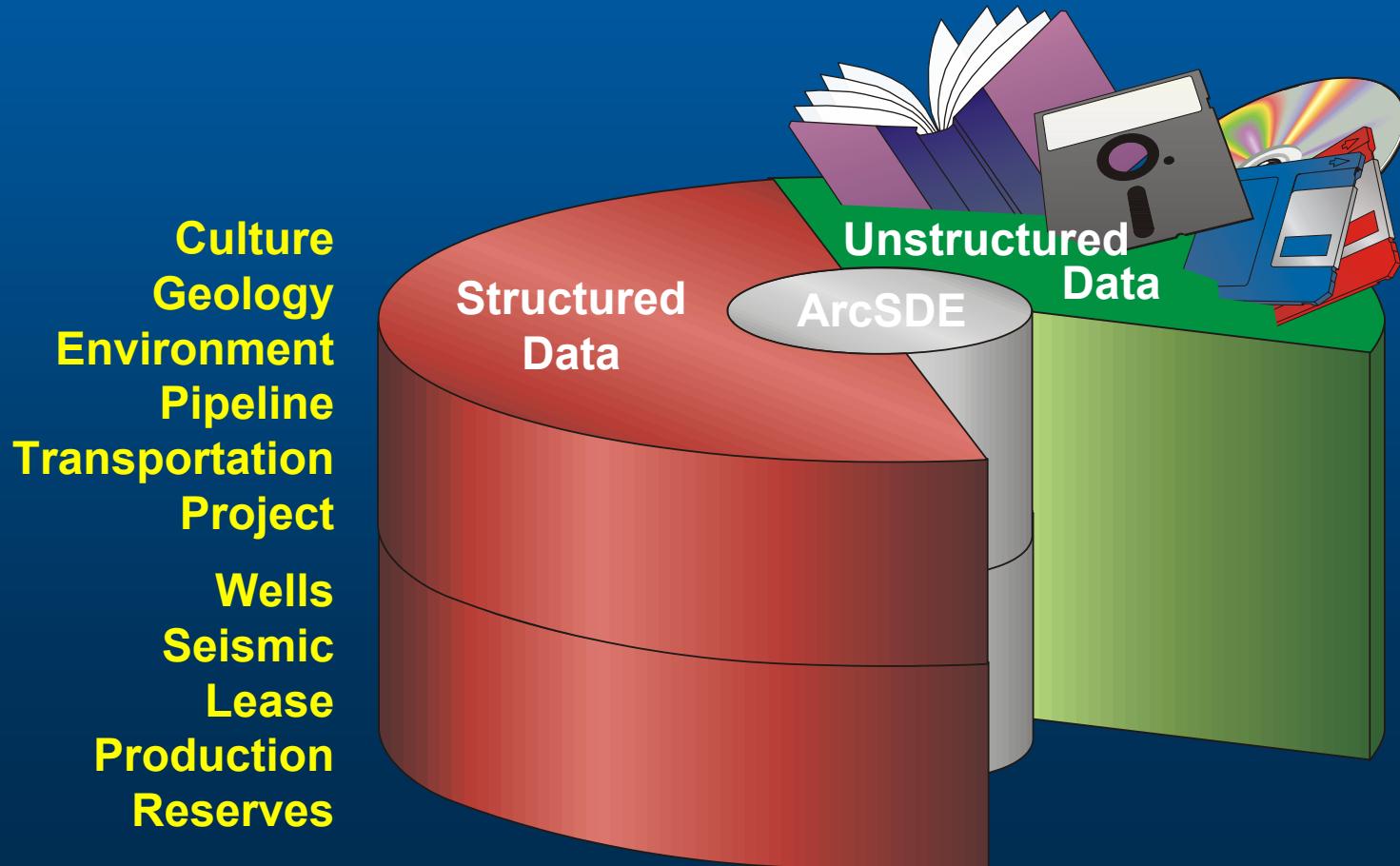
# Building Blocks



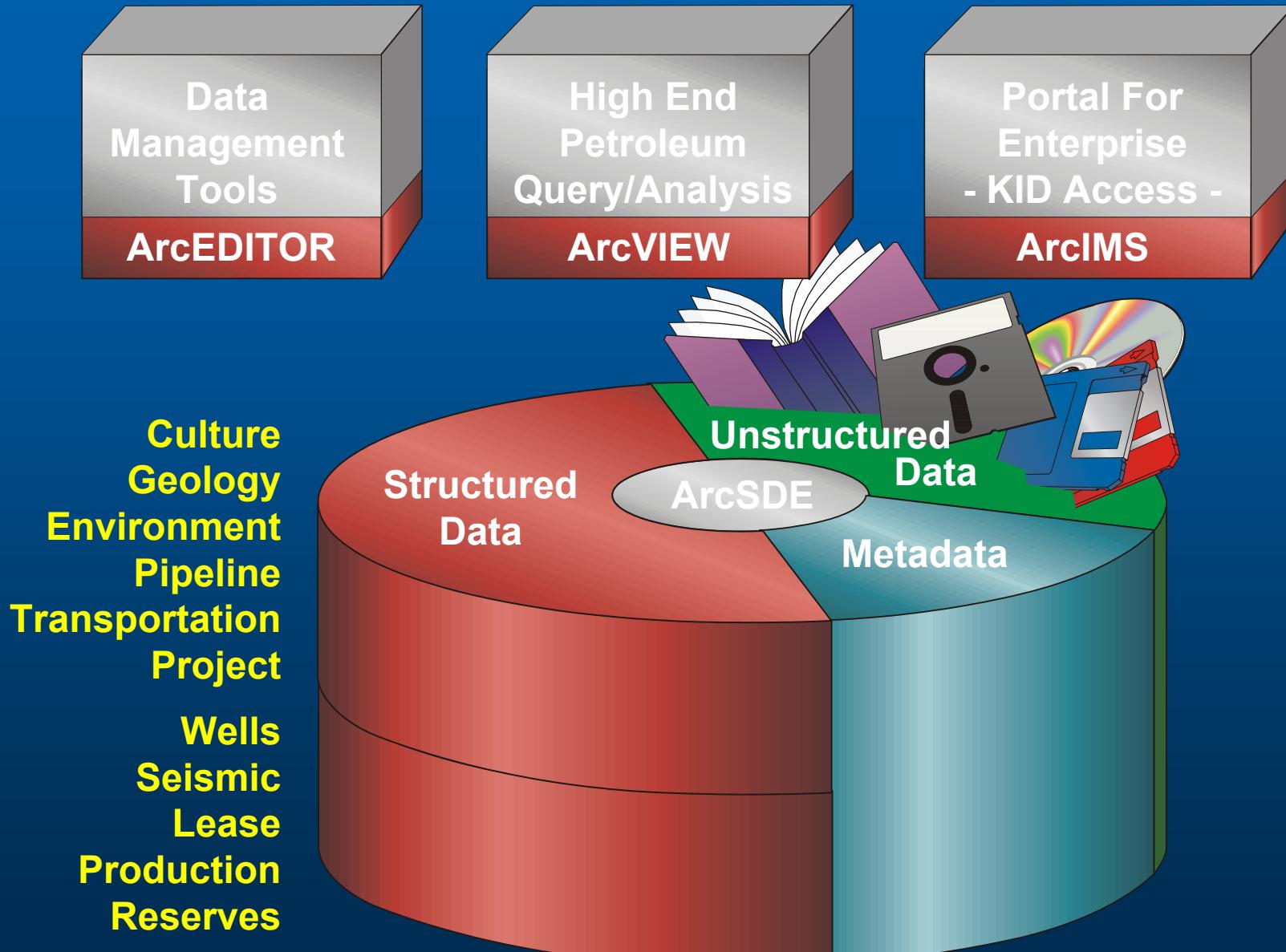
Culture  
Geology  
Environment  
Pipeline  
Transportation  
Project

Wells  
Seismic  
Lease  
Production  
Reserves

# Building Blocks

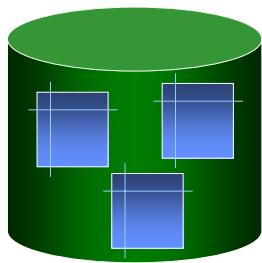


# Building Blocks

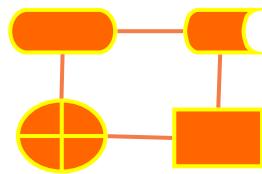


# How Do I Use a Logical Template?

- You may only need a small part of the over all schema and template to match your data



Physical Model  
Database Schema  
Business Rules



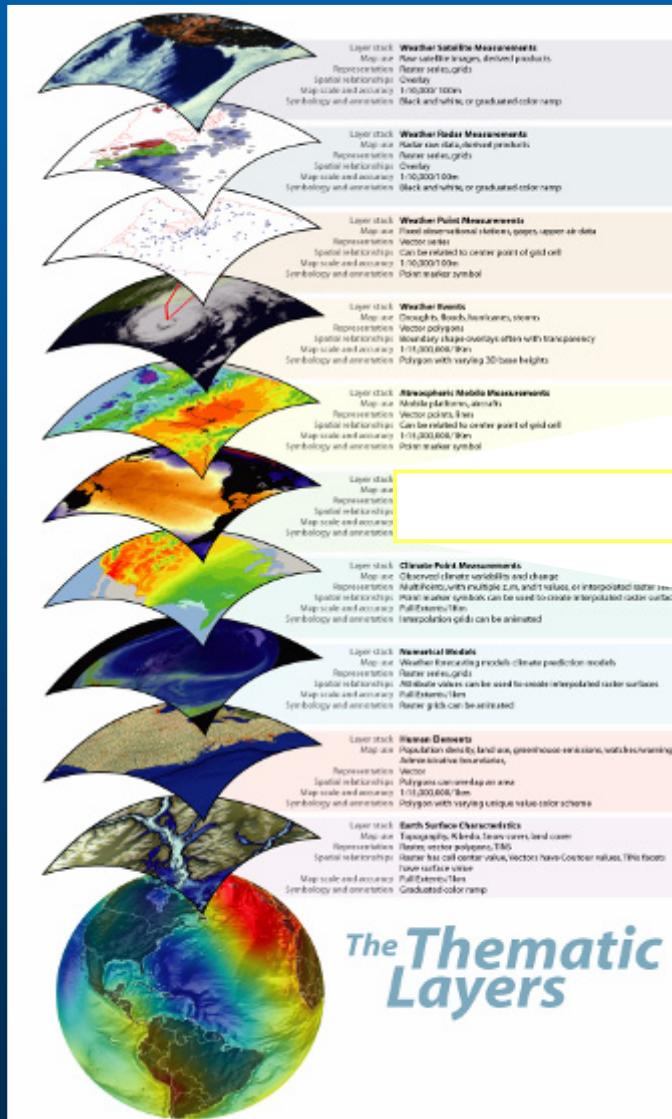
Conceptual Model  
Sketches, Flow Diagrams, etc.

# Differences between stages of the Data Model evolution:

- Conceptual = An overview of abstract ideas that are included in the database
- Logical = A design template that can be used to create or instantiate a database using case tools
- Physical = The parameters and workflow to fine tune the deployment of the database

# The Layer Stack

## *Thematic groupings of data sets*



### Atmospheric Boundaries

Weather fronts, temperature boundaries

Vector polygons, lines

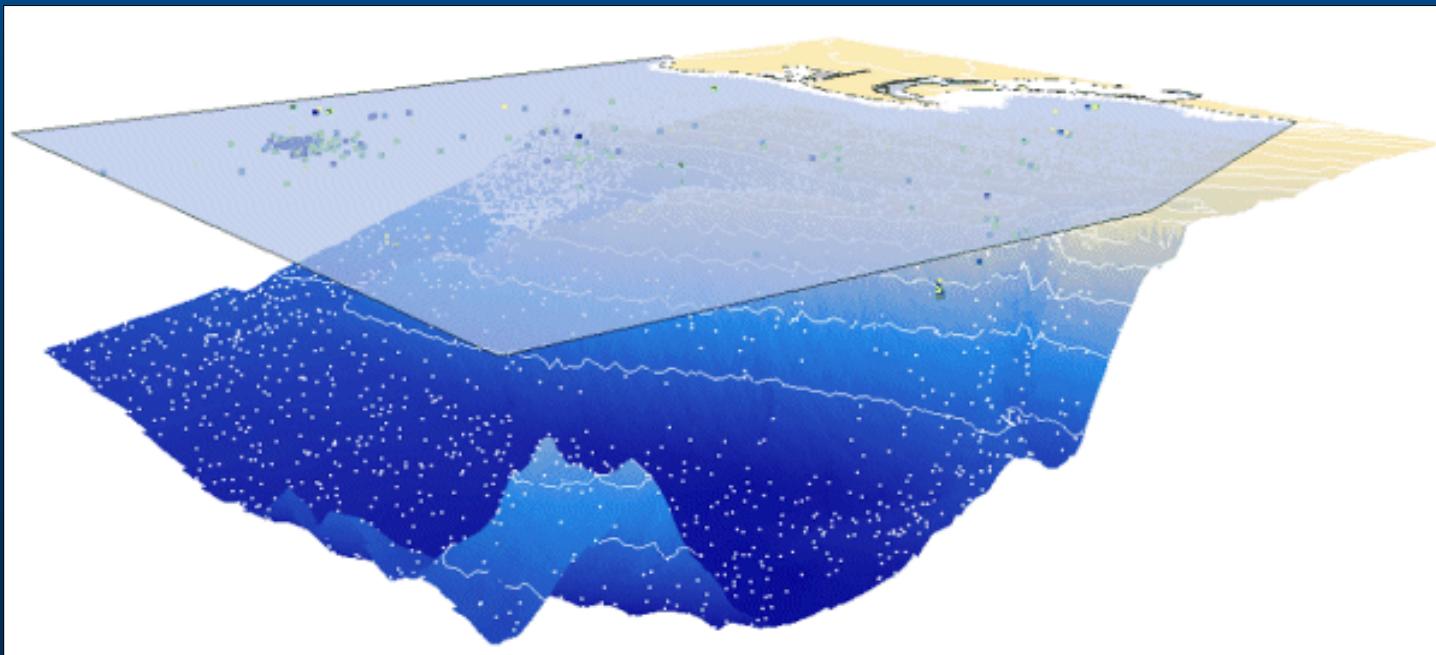
Multiple time series polygons can be merged and animated

1:15,000,000/1Km

High/Low pressure front lines and cones of intensity,can be animated

# Identify the Key Layers

- Based on your information requirements
- Example: Marine data model
  - Bathymetry
  - Soundings
  - Contours
  - Points



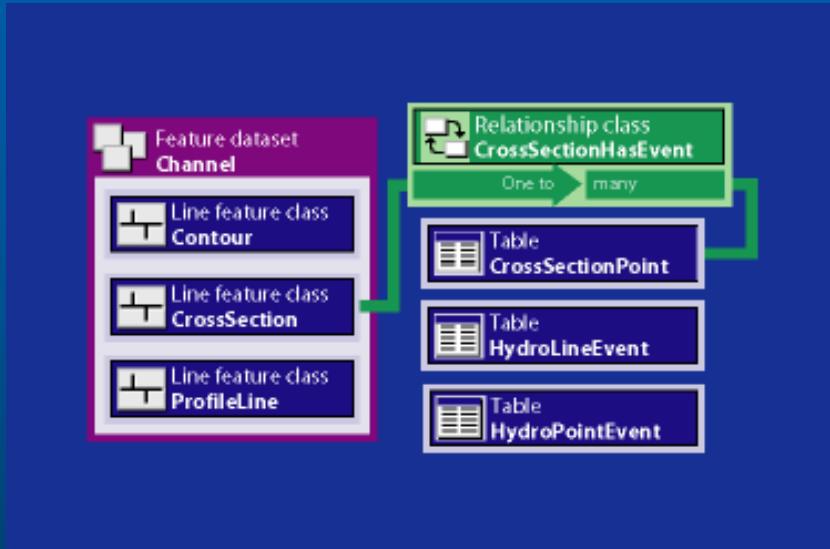
# Ten Steps to Designing Geodatabases



## Conceptual design

- 1. Identify information products to be produced with your GIS.
- 2. Identify key thematic layers based on information requirements.
- 3. Specify scale ranges and spatial representations for each thematic layer.
- 4. Group representations into datasets.

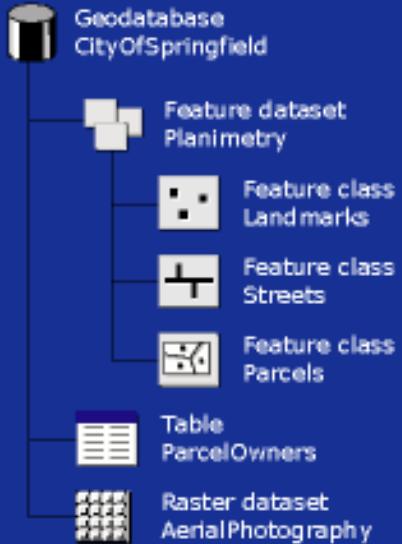
# Ten Steps to Designing Geodatabases



## Logical design

- 5. Define tabular database structure and behavior for descriptive attributes.
- 6. Define the spatial properties of your datasets.
- 7. Propose a geodatabase design.

# Ten Steps to Designing Geodatabases



- **Physical design**
  - 8. Implement, prototype, review, and refine your design.
  - 9. Design work flows for building and maintaining each layer.
  - 10. Document your design using appropriate methods.

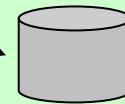
# Data Model Implementation

# Four ways to build geodatabase schema

## Database design

What data?  
Spatial reference?  
Relationships?  
Validation rules?  
Geometric networks?  
Subtypes?

### 1 Create schema with ArcCatalog wizards



# Four ways to build geodatabase schema

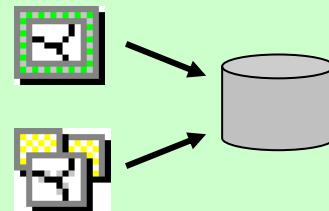
## Database design

What data?  
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### 1 Create schema with ArcCatalog wizards



### 2 Import existing data



# Four ways to build geodatabase schema

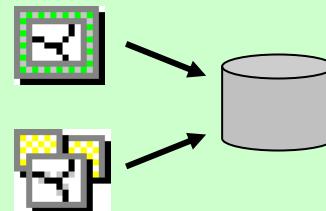
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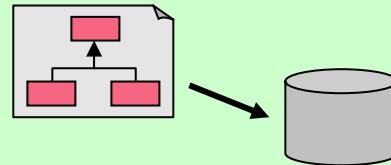
### 1 Create schema with ArcCatalog wizards



### 2 Import existing data



### 3 Create schema with CASE tools



# Four ways to build geodatabase schema

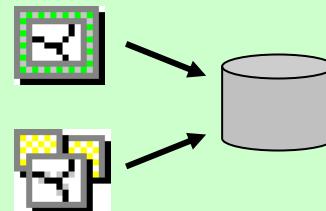
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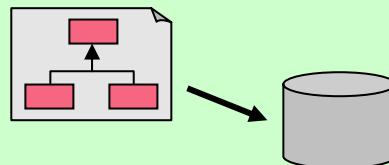
### 1 Create schema with ArcCatalog wizards



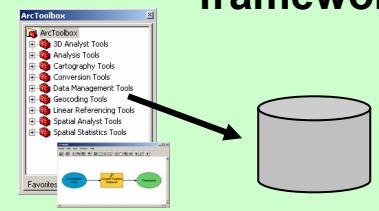
### 2 Import existing data



### 3 Create schema with CASE tools



### 4 Create schema in geoprocessing framework

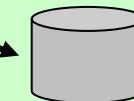


# Four ways to build geodatabase schema

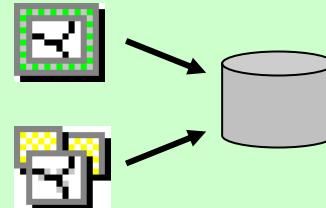
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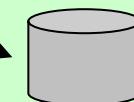
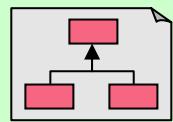
### 1 Create schema with ArcCatalog wizards



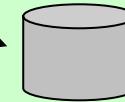
### 2 Import existing data



### 3 Create schema with CASE tools



### 4 Create schema in geoprocessing framework



## Set relationships Set rules

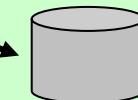
- Domains
- Connectivity
- Relationships
- Topology

# Four ways to build geodatabase schema

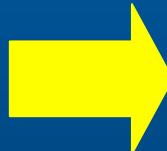
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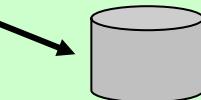
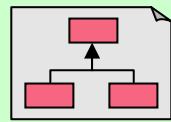
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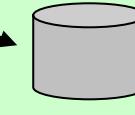
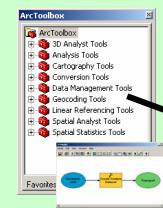
## Set relationships Set rules

- Domains
- Connectivity
- Relationships
- Topology

### 3 Create schema with CASE tools



### 4 Create schema in geoprocessing framework



## Load data



# Data Model Templates

# Petroleum Data Model Templates

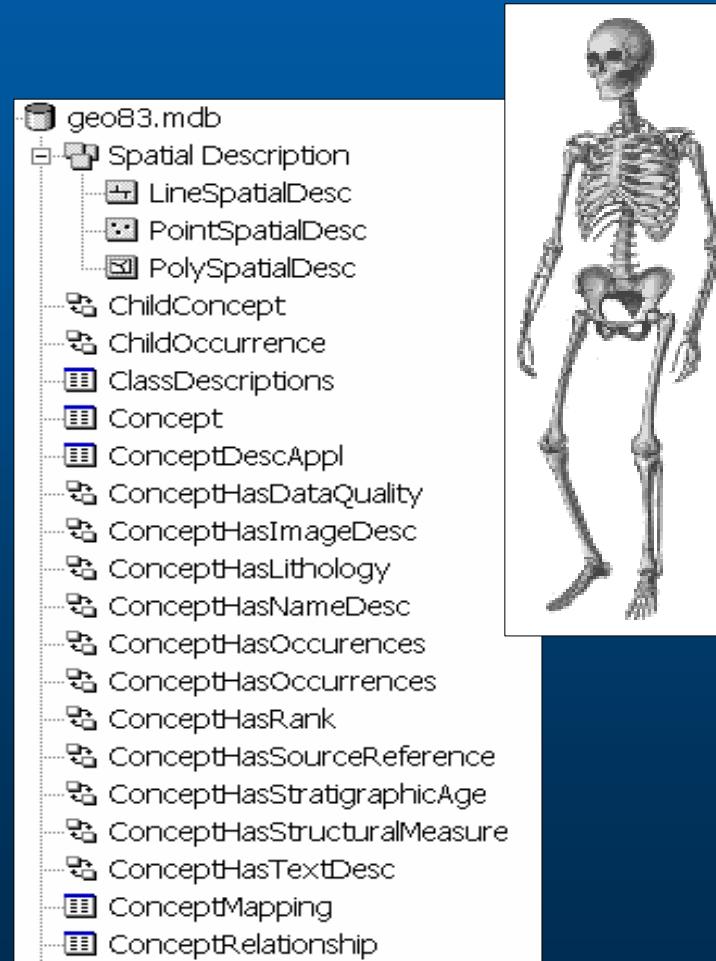
Screenshot of the ESRI Support - Microsoft Internet Explorer browser showing the 'Data Models' page. The page lists various data models with checkboxes for 'Case Studies' and 'Design Templates'. The 'Petroleum' section is highlighted with a blue border.

	Case Studies	Design Templates
Address	✓	✓
Agriculture	✓	
Archiving	✓	
Atmospheric	✓	✓
Basemap	✓	✓
Biodiversity		✓
Census-Administrative Boundaries	✓	✓
Defense-Intel	✓	✓
<b>Energy Utilities</b>	✓	
Energy Utilities - MultiSpeak™	✓	
Environmental Regulated Facilities	✓	
Forestry	✓	
Geology	✓	✓
GIS for the Nation	✓	✓
Groundwater	✓	✓
Health	✓	✓
Historic Preservation and Archaeology		✓
Homeland Security	✓	✓
Hydro	✓	✓
International Hydrographic Organization (IHO) S-57 for ENC	✓	✓
Land Parcels	✓	✓
Local Government		✓
Marine	✓	✓
National Cadastre		✓
Petroleum		✓
<b>Pipeline</b>	✓	✓
Raster	✓	✓

- PPDM
- PPDM Lite
- Pipeline and well data
- Exploration, Conservation

# What's in a Data Model Template?

- A pre-designed schema of Objects
- Feature classes
- Tables
- Relationships
- Domains
- Subtypes



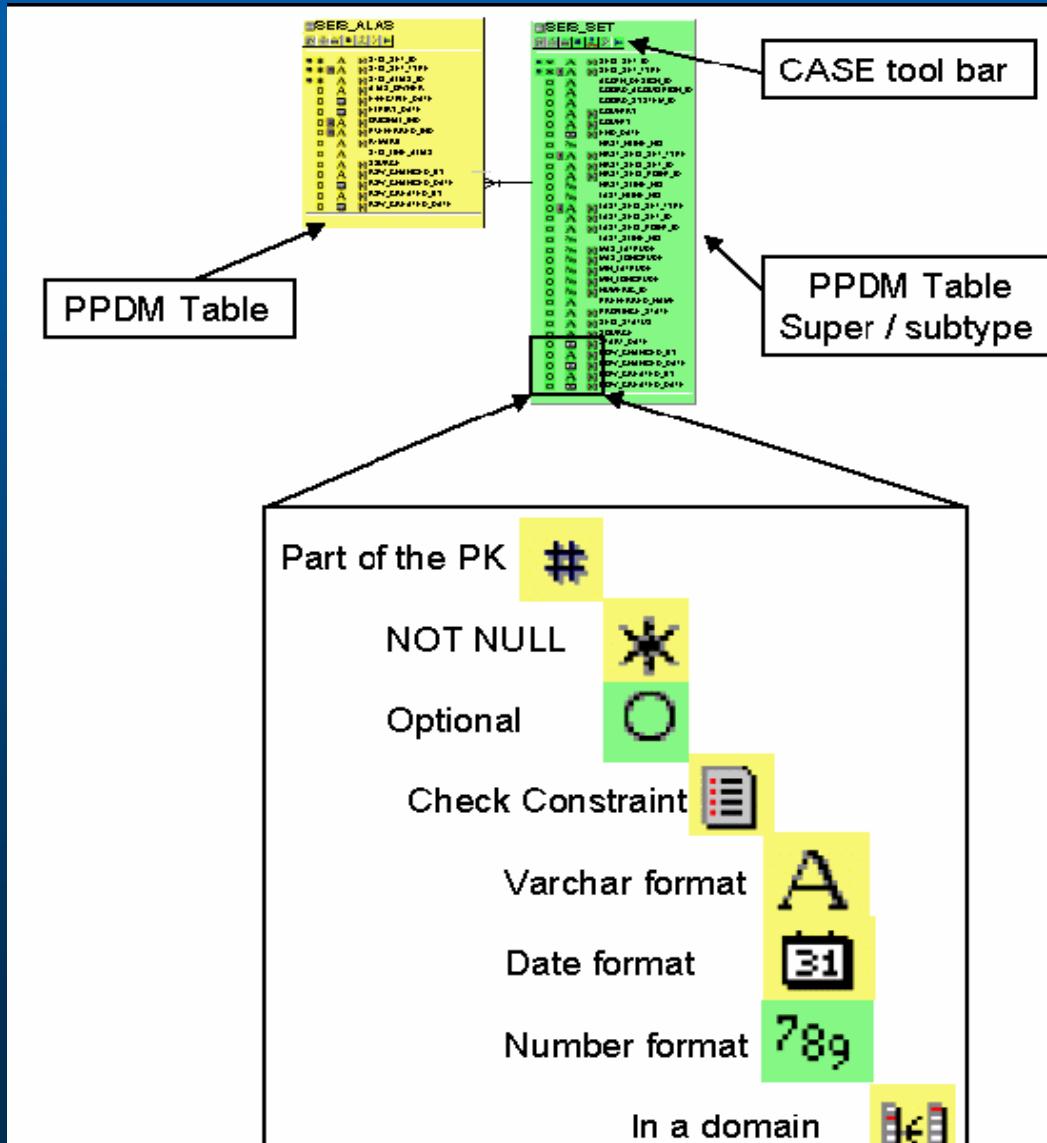
# Electric & Gas Data Model Templates

The screenshot shows a Microsoft Internet Explorer window with the title "Data Models - ESRI Support - Microsoft Internet Explorer". The address bar contains the URL <http://support.esri.com/index.cfm?fa=downloads.dataModels.gateway>. On the left, there's a "Site Help" sidebar with links to Site Map, Coming Soon, Frequently Asked Questions, Browser Support, and Getting Started. The main content area displays a grid of data models. The columns are "Case Studies" and "Design Templates", both indicated by green checkmarks. Several categories are highlighted with blue boxes: "Energy Utilities" and "Energy Utilities - MultiSpeak TM" under "Energy Utilities"; "Pipeline" and "Raster" under "Pipeline".

	Case Studies	Design Templates
Address	✓	✓
Agriculture	✓	
Archiving	✓	
Atmospheric	✓	✓
Basemap	✓	✓
Biodiversity		✓
Census-Administrative Boundaries	✓	✓
Defense-Intel	✓	✓
<b>Energy Utilities</b>	✓	
<b>Energy Utilities - MultiSpeak TM</b>	✓	
Environmental Regulated Facilities	✓	
Forestry		✓
Geology	✓	✓
GIS for the Nation	✓	✓
Groundwater	✓	✓
Health	✓	✓
Historic Preservation and Archaeology		✓
Homeland Security	✓	✓
Hydro	✓	✓
International Hydrographic Organization (IHO) S-57 for ENC	✓	✓
Land Parcels	✓	✓
Local Government		✓
Marine	✓	✓
National Cadastre		✓
Petroleum		✓
<b>Pipeline</b>	✓	✓
<b>Raster</b>	✓	✓

- Electric Distribution
  - ArcFM
  - MultiSpeak
- Electric Transmission
- Gas Distribution
- Gas Pipeline

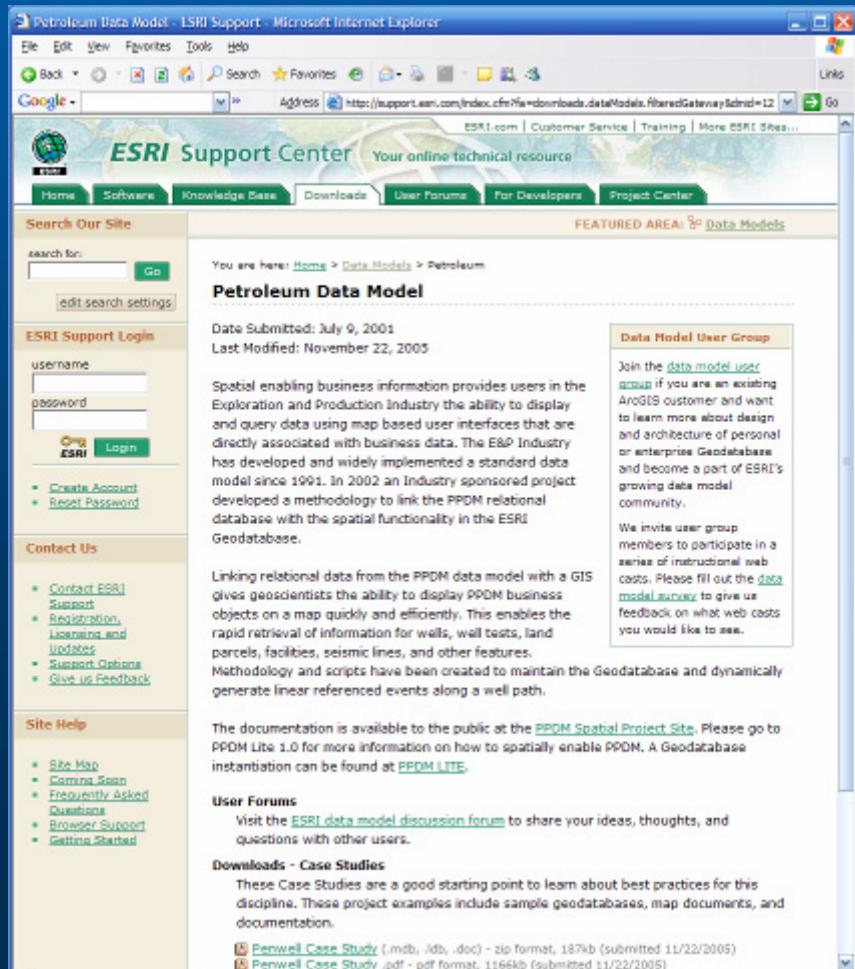
# Which template to use?



# Typical Model Template Layout

- Points, lines, polygons
  - Well Classes
  - Pipelines
  - Basemap surfaces
  - Linear referencing

# Petroleum Templates and Resources

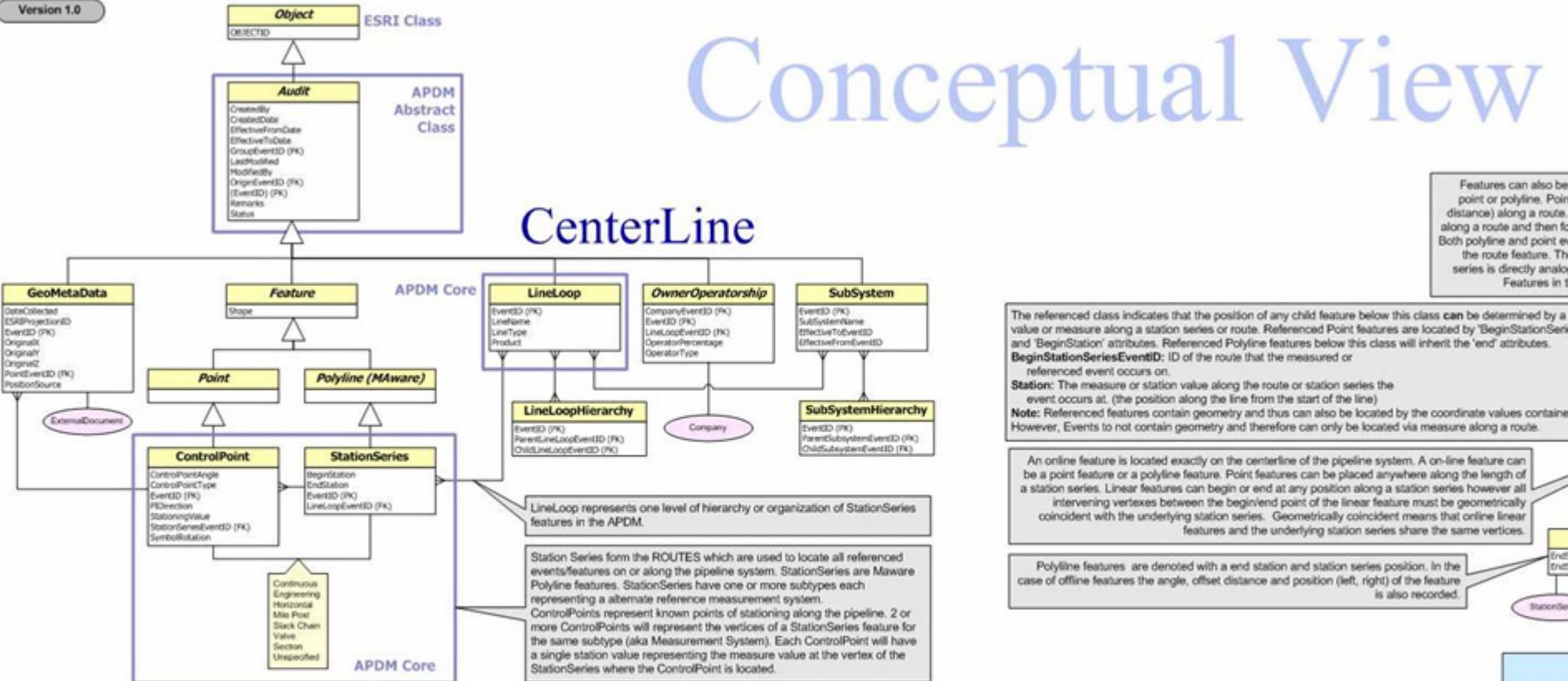


- Logical Models
  - Visio Format
  - GIF Image
- Reference Books
- Tips & Tricks Link

# Logical Design Template (APDM)

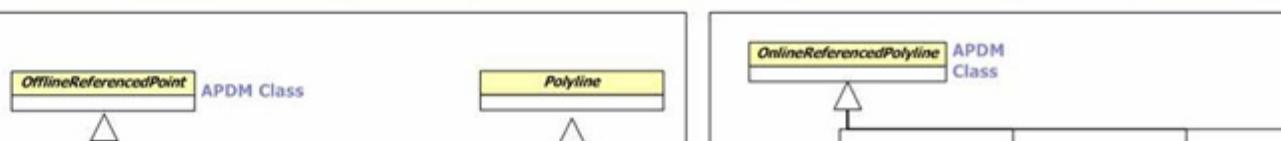
Last Revised: 05/26/2003 - Version 1.0  
 Maintained by M.J. Herter Associates Inc./ESRI on behalf of the ESRI Pipeline Interest Group.  
 Copyright 2002, 2003 Environment Systems Research Institute, Inc. All Rights Reserved.

Version 1.0



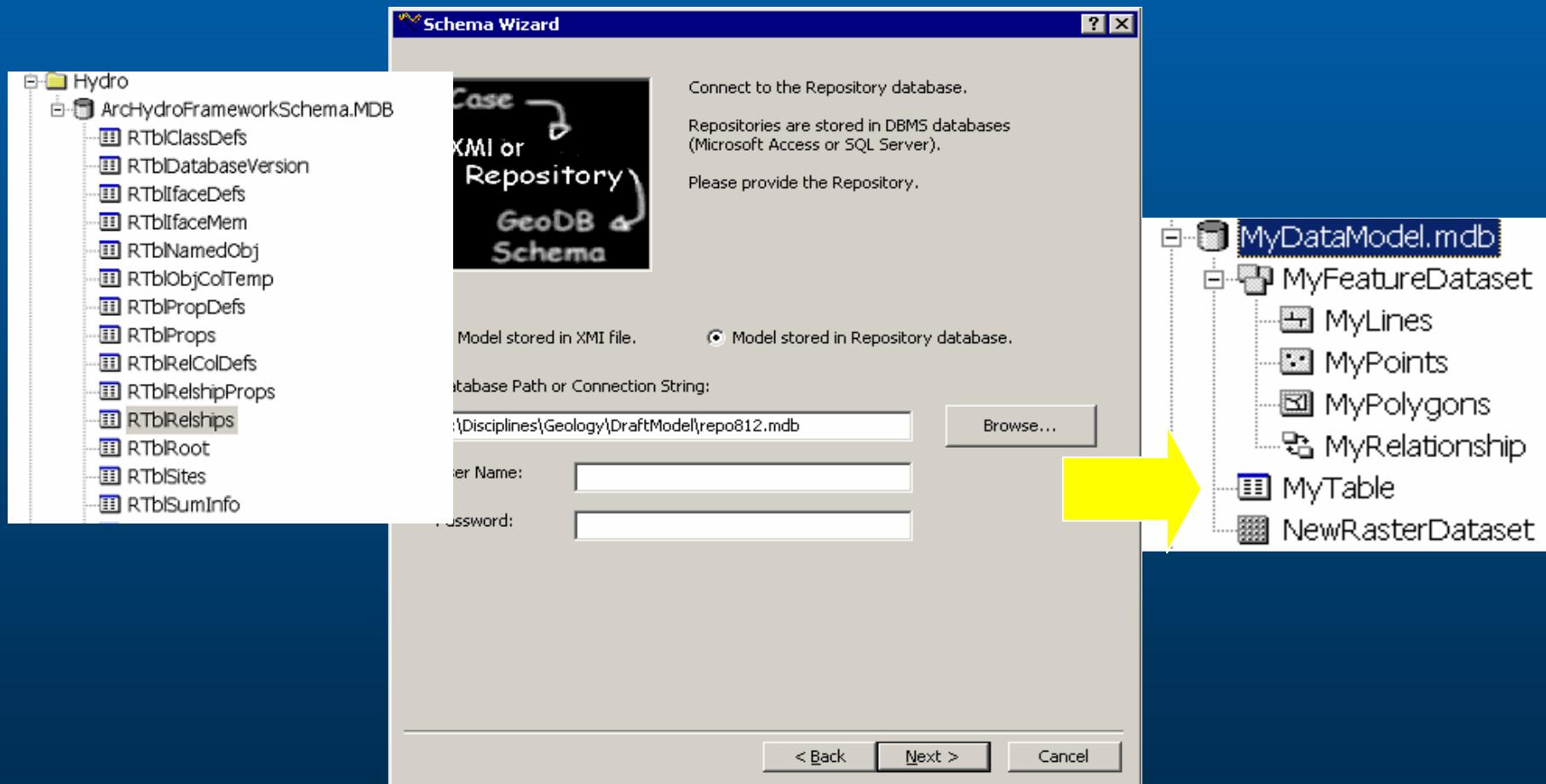
## Feature Classes

Cathodic Protection



# Using a Design Template

*Schema Wizard reads repository or template to create a geodatabase*



# Some Tips and Tricks Online

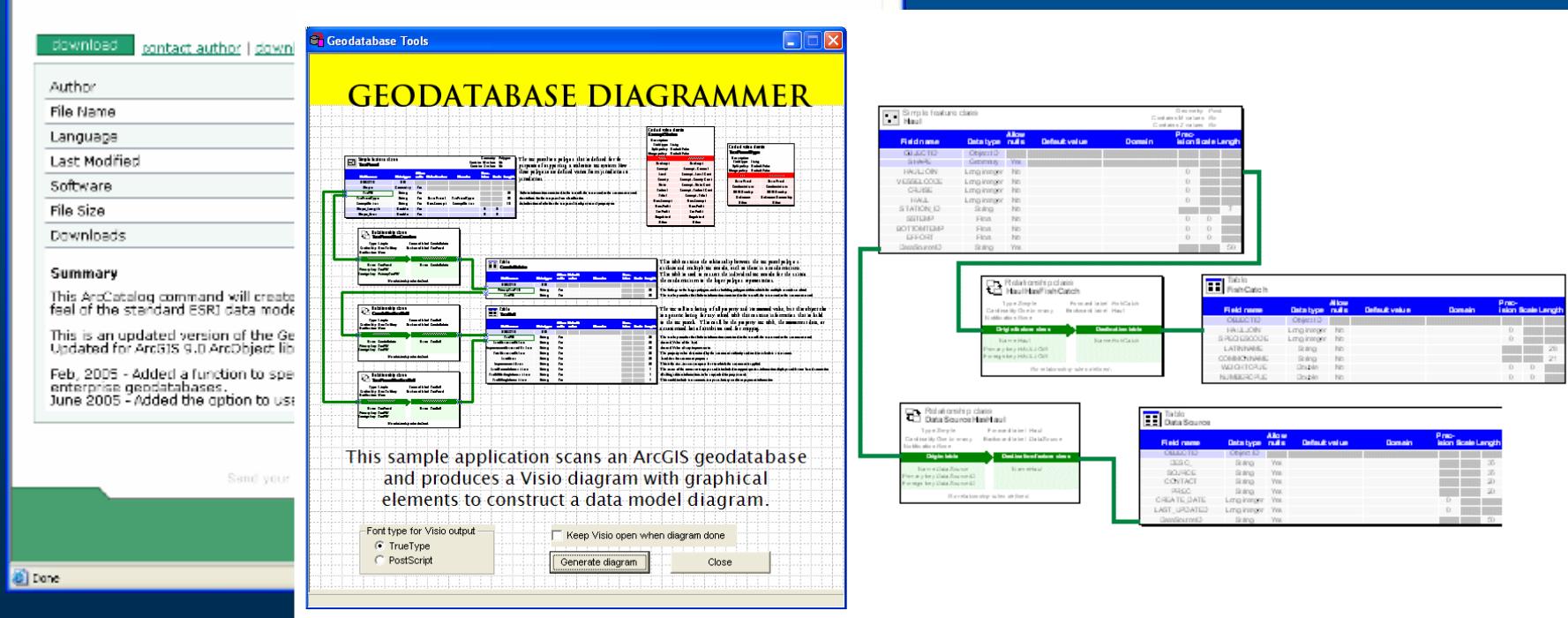
The screenshot shows a Microsoft Internet Explorer window displaying the ESRI Support Center website. The main content area is titled "Data Models Tips and Tricks". It includes a summary section stating: "These tips and tricks are designed to help guide in the use of common data model methods and best practices." Below this is a "Description" section with a link to "UML and Case Tools". A "Supporting Files" section lists several PDF documents:

- Load Data to the Geodatabase - PDF - 116 kb
- Repository in the Geodatabase - PDF - 220 kb
- Managing ArcInfo Layer Connection Properties - PDF - 402 kb
- Spot of Reference in the Geodatabase - PDF - 310 kb
- Ignoring Schema - PDF - 68 kb
- How to Import Schemas from the Geodatabase - PDF - 134 kb
- How to Create a Geodatabase from a Microsoft Repository Database or XML File - PDF - 230 kb
- How to use the SD Interpolator tool - PDF - 234 kb

The left sidebar contains links for "ArcInfo Desktop", "Search", "ESRI Support Login" (with fields for username and password), "Create Account", "Reset Password", and "Contact Us" (with links for "Report Technical Support", "Software & Software Enhancement", "Products", "Registration", "Licensing and Auditing", "Support Options", and "Provide Feedback"). The bottom sidebar includes links for "Site Map", "Coming Soon", "Program Asked Questions", "Browse Support", and "Getting Started".

# Geodatabase Diagrammer

## Create graphical representation of geodatabase



# Geodatabase Designer

## *Import / Export Geodatabase Schema*

ArcScripts Details - ESRI Support - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Favorites Home

Address http://arcscripts.esri.com/details.asp?db\_id=13486

ESRI Support Center Your online technical resource

Home Software Knowledge Base Downloads User Forums For Developers Project Center

FEATURED TECHNOLOGY: Geoprocessing Data Models

You are here: Home > Downloads > ArcScripts > Search Results > Script Details

Login | Feedback | Help

**Geodatabase Designer v2 (9.x)**

[download](#) [contact author](#) [download help](#) [add bookmark](#) [view bookmarks](#)

Author	Silvie Carmichael
File Name	GeodatabaseDesigner2.zip
Language	Visual Basic
Last Modified	JUL 27 2005
Software	ArcGIS Desktop
File Size	7555 kb
Downloads	3363

**Summary**

[SOURCE CODE INCLUDED]

Welcome to Geodatabase Designer v2.0

GDD is set of tools to export and import geodatabase schema using XML.

After installation please view demonstration video. From the start menu select:  
START > PROGRAMS > GEODATABASE DESIGNER 2 > VIDEO DEMONSTRATION - INTRODUCTION (AVI)

New with this release (2.0.230) is the ability to embed geodatabase XML schema in geodatabase metadata. For demonstration please view:  
START > PROGRAMS > GEODATABASE DESIGNER 2 > VIDEO DEMONSTRATION - METADATA (AVI)

The Embedded window contains three tabbed views:  
1) Import/export operation log  
2) XML viewer/editor  
3) HTML viewer (of XML).

Please report any bugs using the "Contact Author" hyperlink above.

Enjoy,

Internet

# Geodatabase Reporter

## Create hyperlinked HTML reports of geodatabase

A screenshot of a Microsoft Internet Explorer window displaying the ESRI Support Center website. The title bar reads "ArcScripts Details - ESRI Support - Microsoft Internet Explorer". The address bar shows the URL "http://arcscripts.esri.com/details.asp?ID=12603". The main content area shows details for "Geodatabase Reporter.NET (9.x)". Key information includes:

Author	Richie Carmichael
File Name	GeodatabaseReporter90Final.zip
Language	C#
Last Modified	Jul 20 2005
Software	ArcGIS Desktop
File Size	6331.02 kb
Downloads	1643

**Summary**  
[SOURCE CODE INCLUDED]  
Geodatabase Reporter is a productivity and diagnostic tool for personal and SDE geodatabases. The key features of Geodatabase Reporter.NET are:  
- Schema Reporting  
- Data Reporting  
- Geometric Network Rule Editor  
- Topology Rule Editor  
  
Geodatabase Reporter.NET is developed on top of Microsoft's .NET Framework and ESRI's ArcEngine by ESRI's Application Prototype Lab in Redlands, California.  
  
Geodatabase Reporter.NET can be used as standalone application or used in conjunction with ArcCatalog for ArcGIS 9.0. Regardless Geodatabase Reporter.NET consumes an ArcEngine (or better) license. For more information on regarding ESRI's products and services please visit <http://www.esri.com>.  
  
PREREQUISITE:  
- Microsoft Windows 2000/XP  
- Microsoft .NET Framework v1.1  
  
HOW TO INSTALL THE ESRI .NET ASSEMBLIES:  
<http://support.esri.com/index.cfm?fa=forums.gateway>

# For More Information

- ESRI Virtual Campus
  - Using CASE Tools (for ArcEditor and ArcInfo)
  - Creating, Editing, and Managing Geodatabases for ArcGIS 9
  - Creating and Editing Geodatabase Features
- ESRI Instructor - Led Training
  - Modeling Geodatabases Using CASE Tools
  - Geodatabase Design Concepts
  - Building Geodatabases I
  - Building Geodatabases II

# For More Information

- ArcGIS Data Models Web site  
<http://support.esri.com/datamodels>
- Sample Case Study
  - within ArcGIS Data Models > Petroleum
- PPDM Spatial main website
  - linked from ArcGIS Data Models > Petroleum  
[www.pppdm.org/standards/spatial](http://www.pppdm.org/standards/spatial)
- PPDM Lite workflow  
[www.pppdm.org/standards/spatial/ppdm\\_lite.html](http://www.pppdm.org/standards/spatial/ppdm_lite.html)
- PPDM Lite online documentation  
[www.pppdm.org/standards/model/lite\\_v1/documentation/html/index.html](http://www.pppdm.org/standards/model/lite_v1/documentation/html/index.html)