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The Structure of Water-Use Databases

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Mid-Atlantic Water-Use Workshop
19 April 2010
USGS MD Water Science Center Office, Baltimore

U.S. Department of the Interior
U.S. Geological Survey

Basic Water-Use Questions*

- Where does our water come from?
- Where does it go?
- What is the water used for?
- Who is using it?
- How much is used?

- How do these facts change over time?

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* Grammar check deliberately ignored...

Background

- **NEWUDS**
  - New England Water-Use Data System
  - Origin: Database needed for data related to the WRD 5-year aggregation – to replace ad hoc district files and methods. Design centered around a conveyance-based model.
  - 1998 - Implementation in NH/VT, MA/RI, CT
  - Published design document (2001) and User Manual (2003)
  - Several USGS Projects in RI and NH have used NEWUDS
  - RI developed a customized version as its state water-use database

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Background

- **NJWaTr**
  - New Jersey Water Transfer Database (aka NJ Water Tracking Model)
  - Origin: Database needed to support work related to the State Water Supply plan and other projects. A conveyance-based data system designed by USGS for NJGS requirements (2000-2003)
  - Published design document
  - Shares the conveyance core object model with NEWUDS
    From-To Sites and conveyance-based quantities
  - Extended Location and Resource features
  - Serves as the defacto New Jersey State Water-Use database

  * NJ WSC is providing NJGS with database support, and the review, QA, and repair of annual state water-use data received from NJDEP

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Background

- **SWUDS**
  - **USGS Site-specific Water Use Data System (aka SSWUDS)**
  - **Origin: A component of the USGS NWIS system. Shares the Sitefile with QW, GW, and ADAPS (SW network, gages). Latest versions support both site-specific and conveyance-based data.**
  - **Todd Augenstein will provide background and details for both SWUDS and AWUDS (Aggregate Water-Use Data System).**
  - **SWUDS has been around a long time although not all USGS WSC's use it, for various reasons**
  - **SWUDS has a support application for data prep, import, and QA**

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Conveyance-Based Data Model

How should we represent water-use data and activities?

A Conveyance-based model can represent any water exchange activity between two objects - and promotes network / pathway thinking

From A → To B

Pairs of Sites are joined through unidirectional Conveyances for which water Transfer Quantities are recorded

Site-Conveyance chains represent the Site-to-Site-to-Site transfers as a network of interconnected sites of various types, tracking water from its source to its final point of consumption or return

"Water-use" contains the infrastructure elements that interact directly with the natural hydrologic system through withdrawals and returns, and also includes the various treatment, distribution, user/application, collection, consumption, loss, and gain entities.

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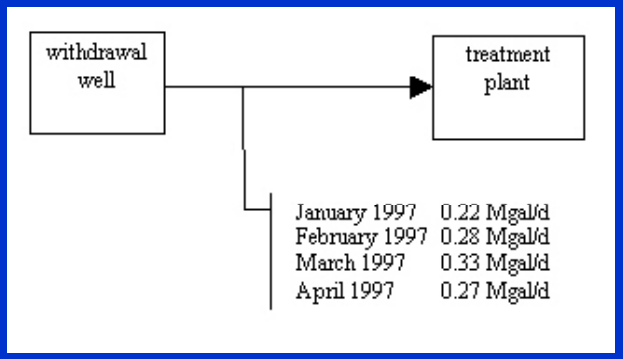
Conveyance-Based Data Model

Simple Water Network

2 Sites, 1 Conveyance

Public Supply Well at a Water Treatment Plant



Conceptual representation of a 2-Site, 1-Conveyance water-use network

A Site is any object that can be the Source or Target of a water Transfer.

A Conveyance defines the Transfer direction and anchors the Volume details.

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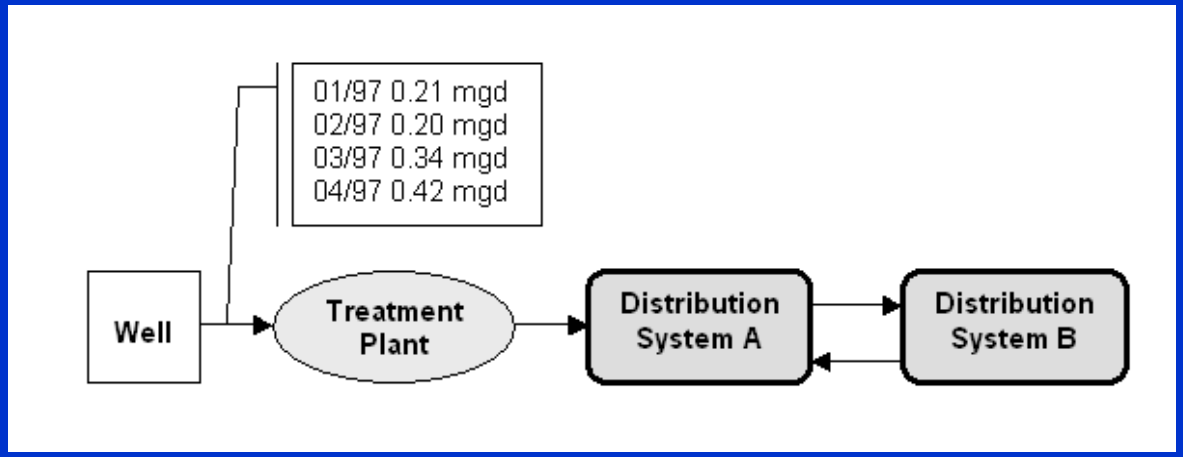
Conveyance-Based Data Model

Simple Water Network

4 Sites (3 Types), 4 Conveyances



Conceptual representation of a network of 4-sites, two of which can exchange water in either direction

Water networks can be extended by defining and adding Sites and their unidirectional Conveyances

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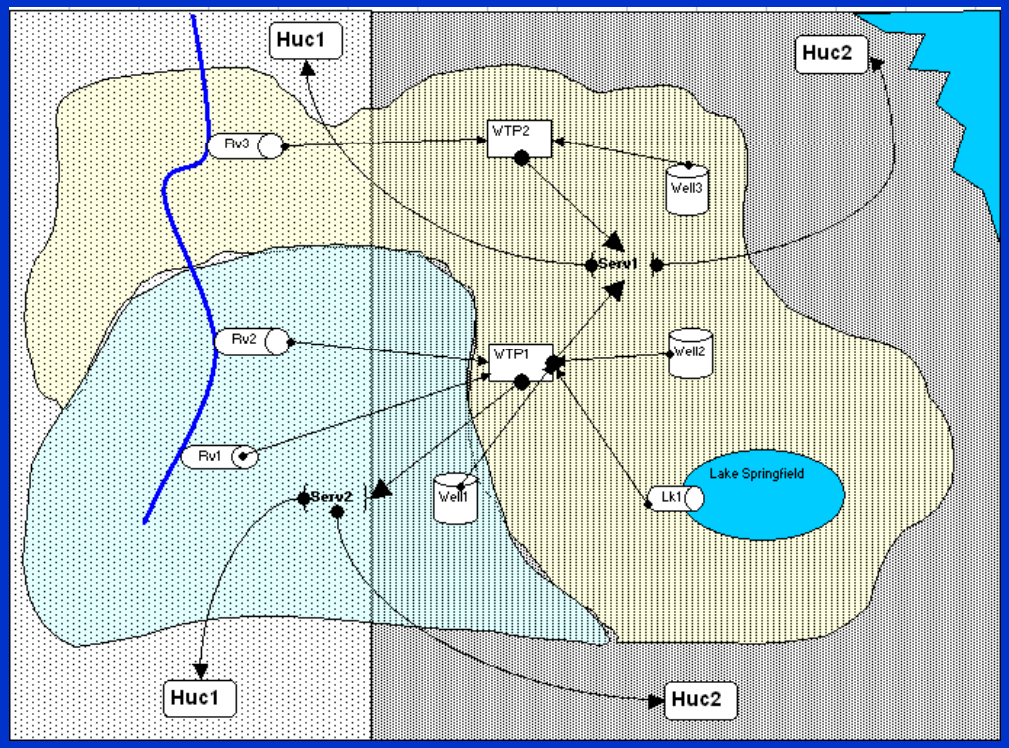
Conveyance-Based Data Model

A More Complex Water Network

14 Sites (5 Types, 3 Spatial Scales), 14 Conveyances (4 Types)



Any complex water network can be represented by a collection of Sites/Conveyances.

A 'Site' may also represent aggregate objects, such as purveyor area or 'county livestock'

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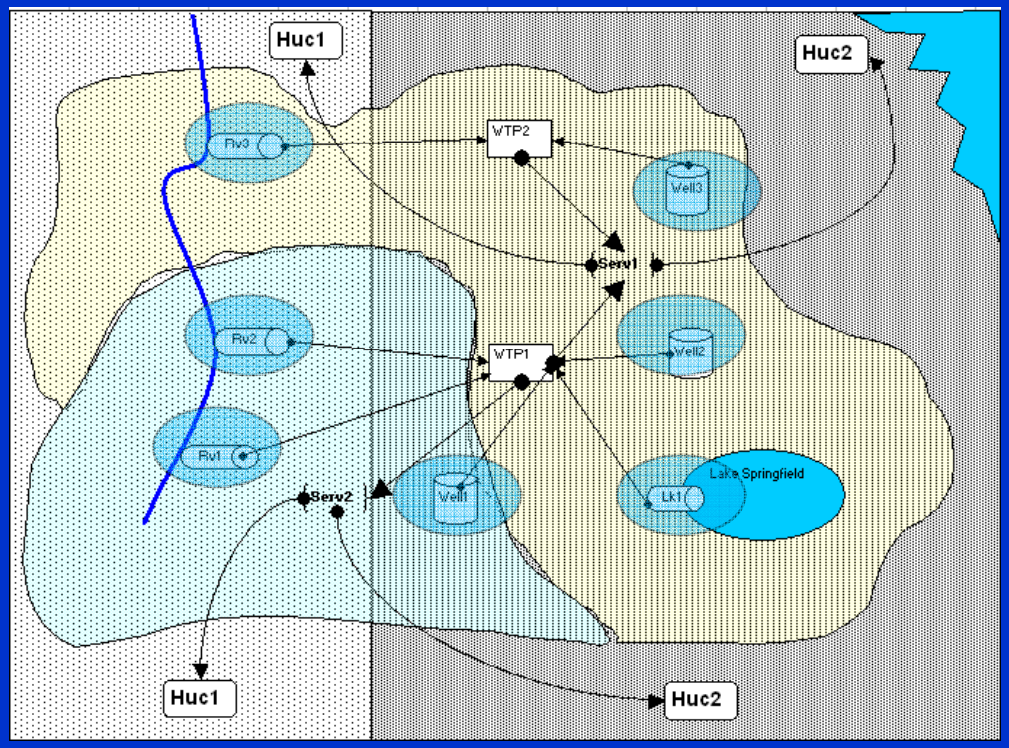
Conveyance-Based Data Model

** There are Two Main Classes of Sites **

Resource-Interactors – and then all the others



Resource-Interactors are those Sites that interact with the hydrologic system and can be associated with Water Resources (aquifers, rivers, lakes, reservoirs). These are Withdrawal and Return Sites.

All Other 'Sites' are part of the controls and infrastructure that manage the handling, treatment, transfer, distribution, collection, uses, consumption, and applications of water.

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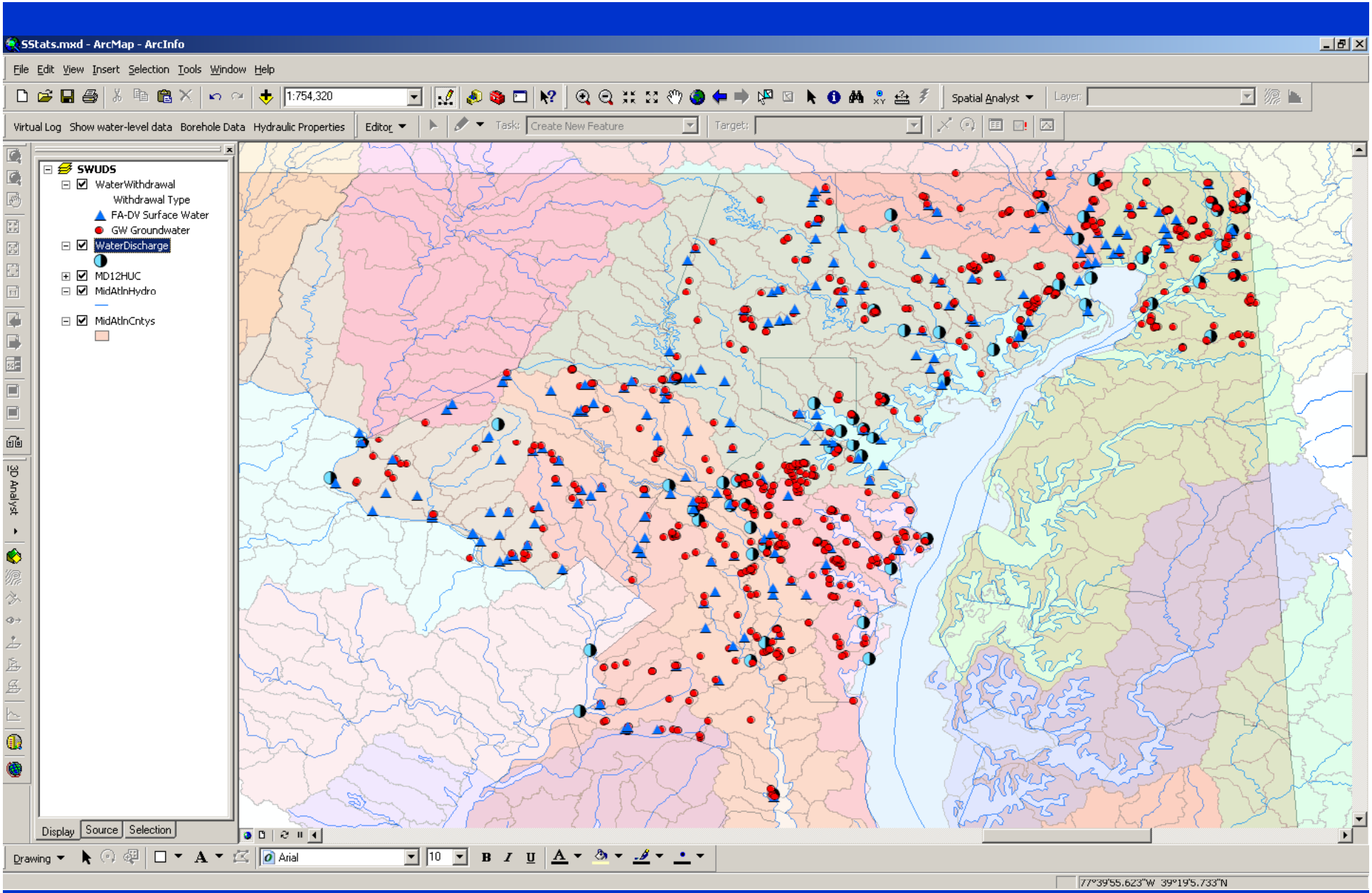
Only 'withdrawal' Resource-interactor Sites are shown in this diagram



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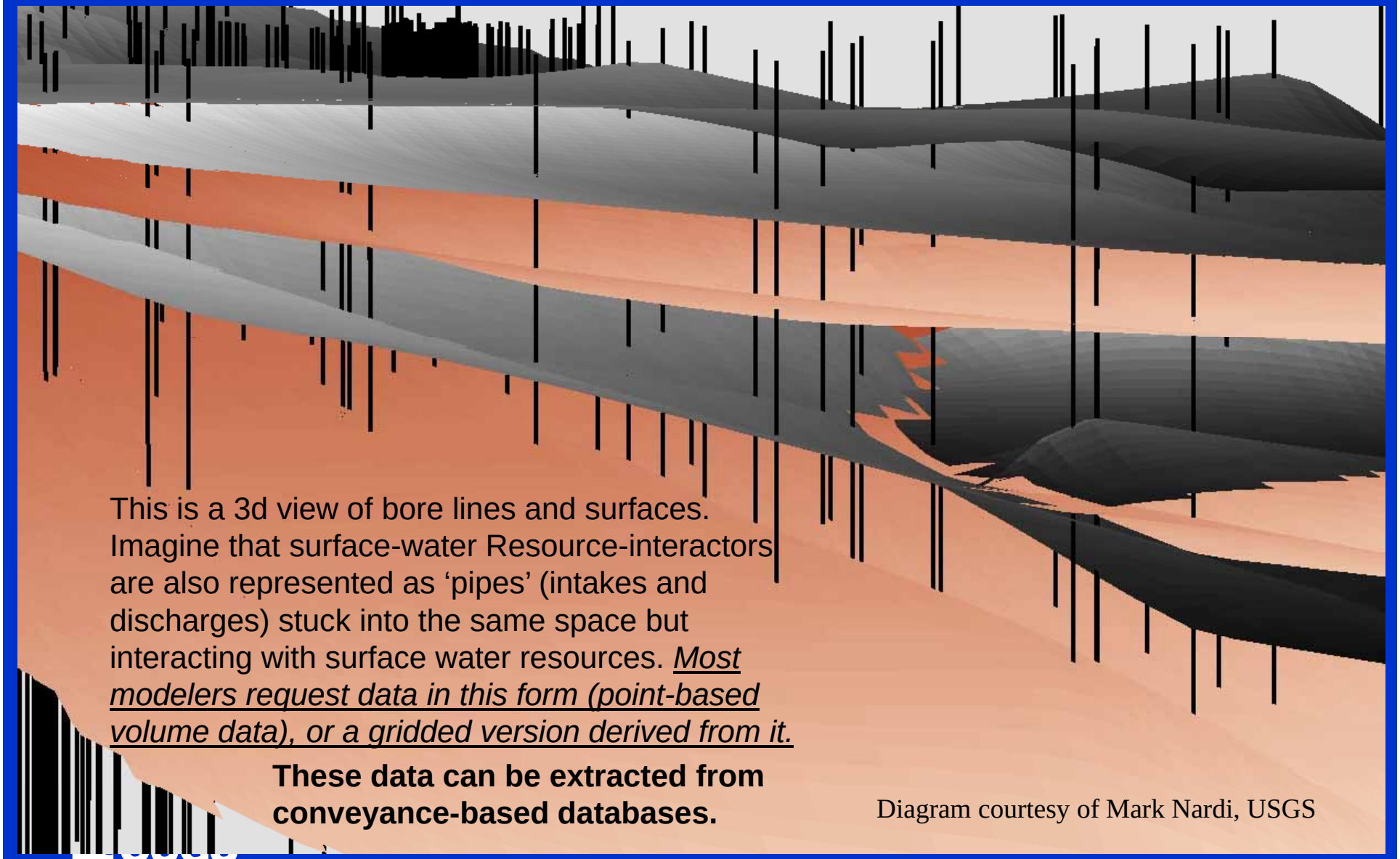
Slide courtesy of Mark Nardi, USGS



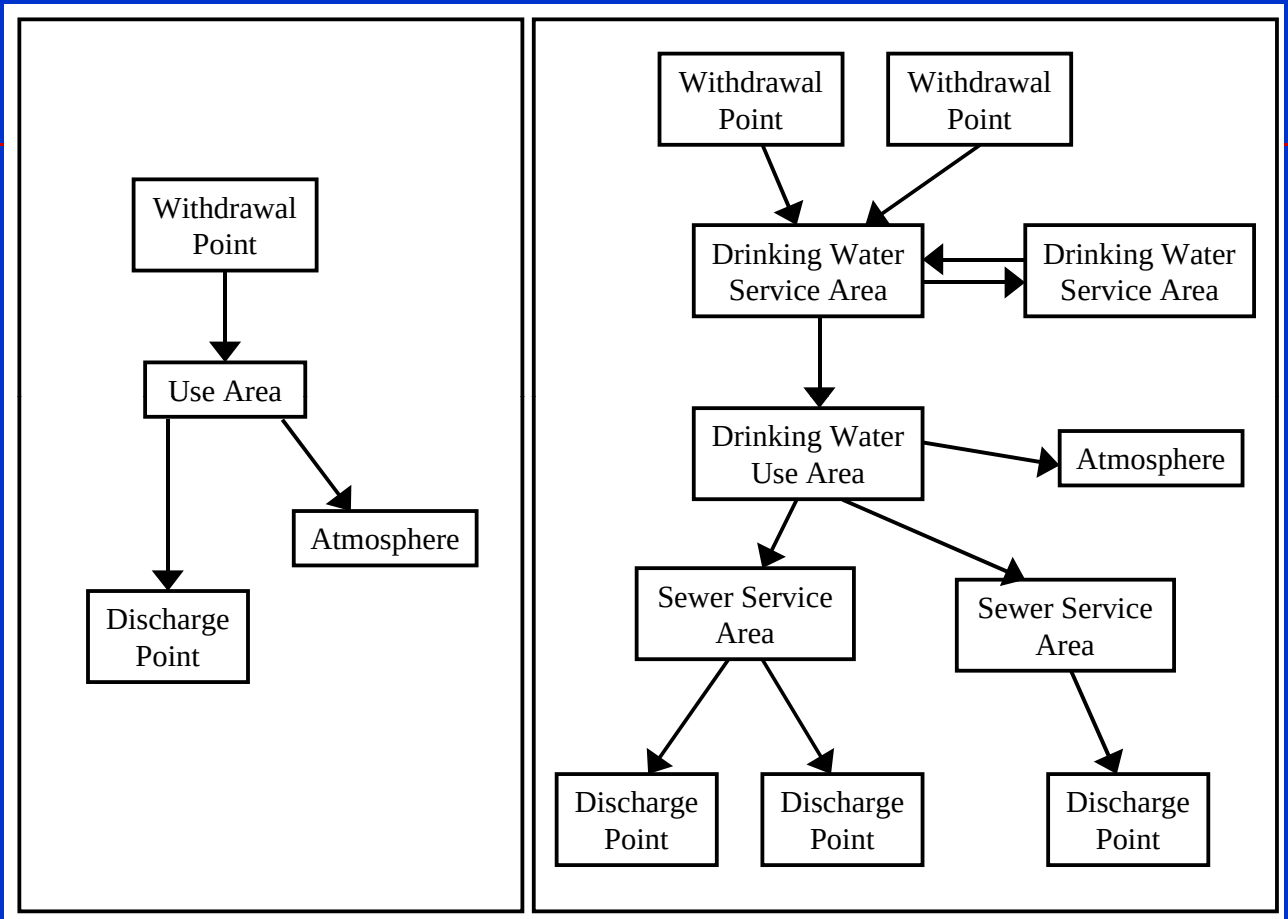
This is a 3d view of bore lines and surfaces. Imagine that surface-water Resource-interactors are also represented as ‘pipes’ (intakes and discharges) stuck into the same space but interacting with surface water resources. *Most modelers request data in this form (point-based volume data), or a gridded version derived from it.*

These data can be extracted from conveyance-based databases.

Diagram courtesy of Mark Nardi, USGS

Back to Conveyance Patterns

Self-supplied commercial and industrial, agricultural, power generation, irrigation and mining uses



Potable supply and wastewater

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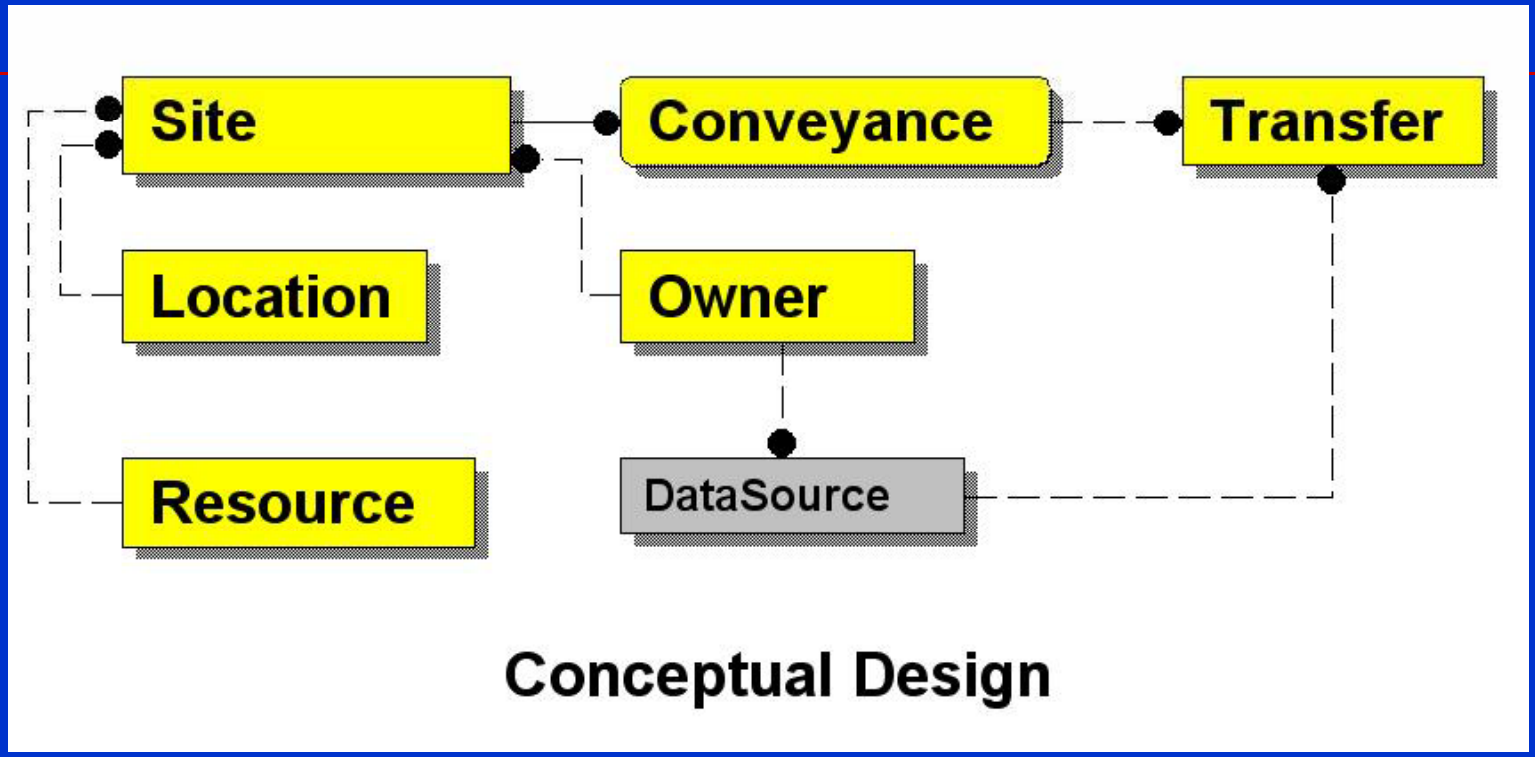
Slide modified from one by Steven Domber, NJGS

NJWaTr Core Conveyance Model



Sites are paired to form unidirectional **Conveyances** for which **Transfer** volumes are recorded. Sites have **Locations** and **Owners**, and some interact with water **Resources** (surface- and ground-water)

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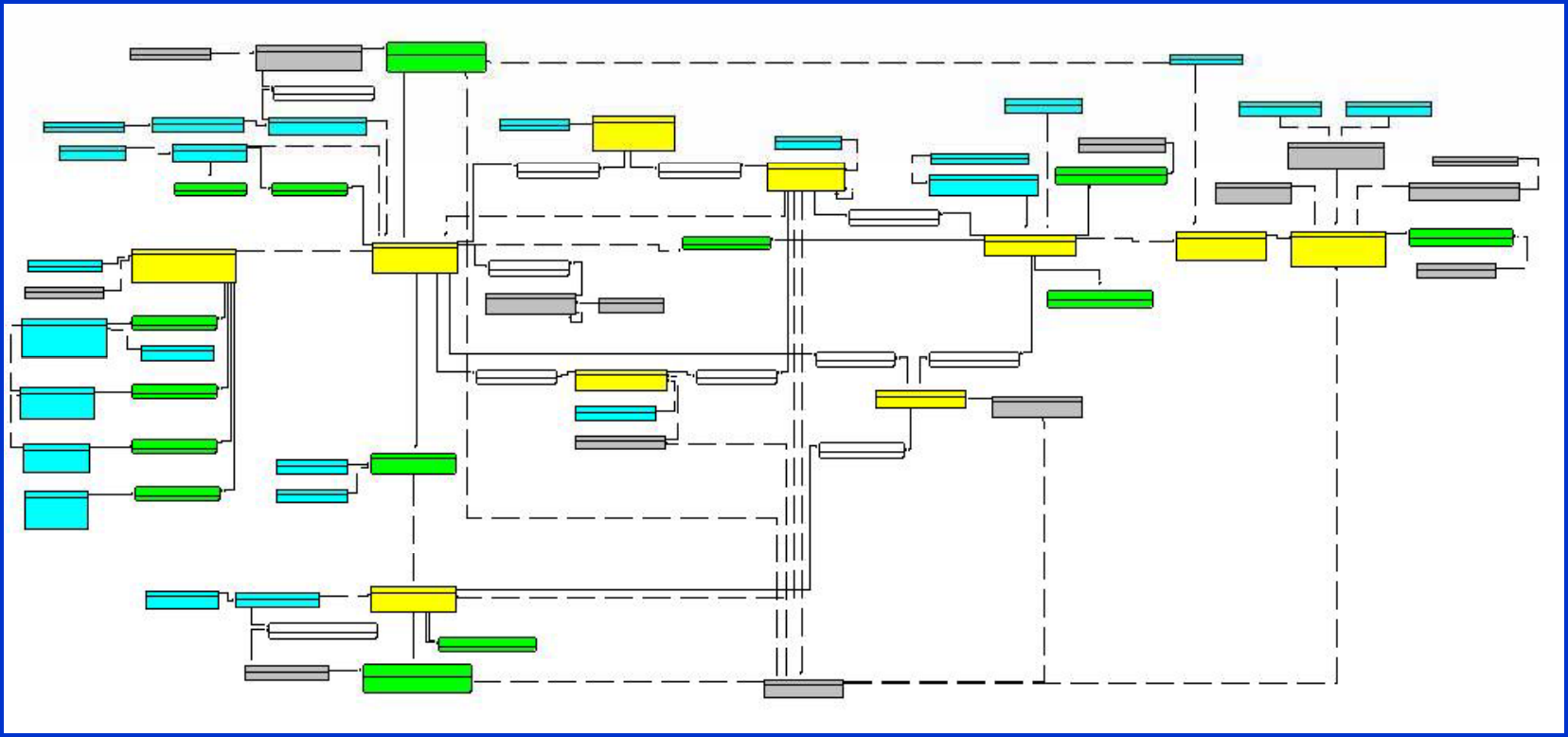
NJWaTr
Full Relational Data Model

76 Tables, 95 relationships, 319 fields, >6,500 lookup values (blue & gray tables)



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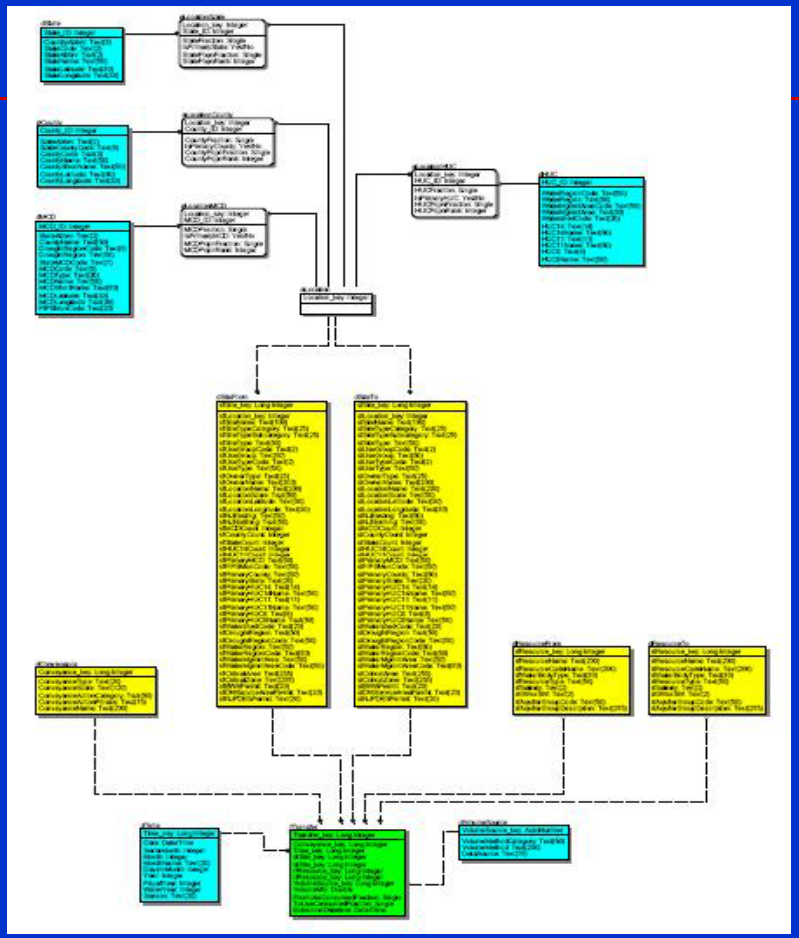
NJWaTr
Data Warehouse Design - Dimensional Model



17 Tables, 17 relationships, 205 fields, >7,400 lookup values (blue tables)

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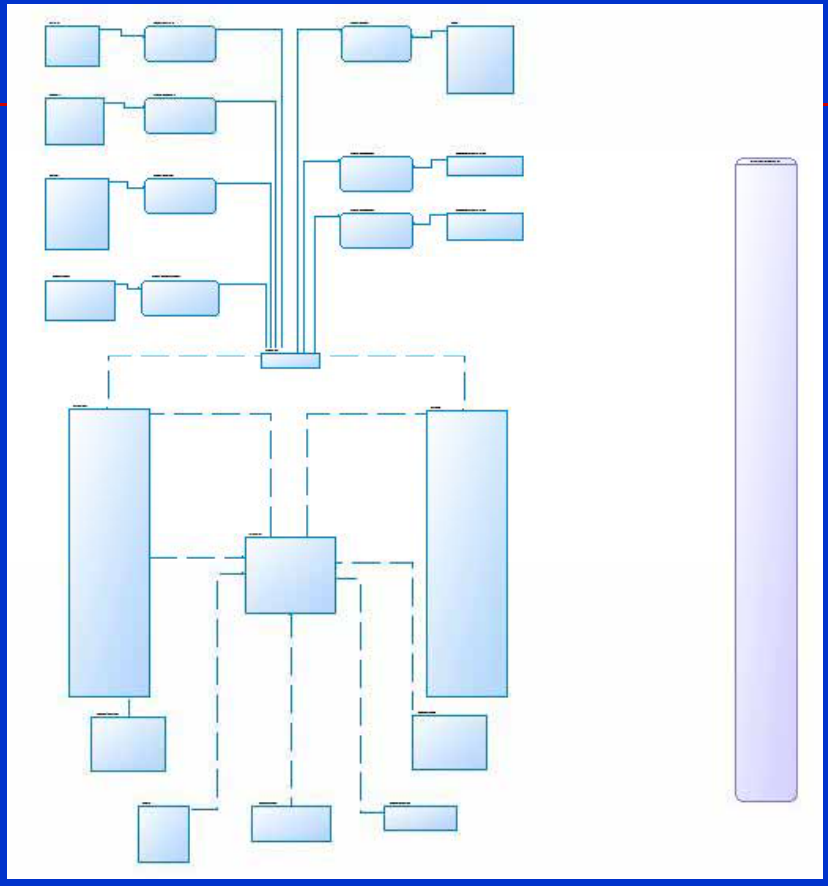
NJWaTr
Data Warehouse Design - Dimensional Model



Users can create custom queries and extract tables via the DW structure

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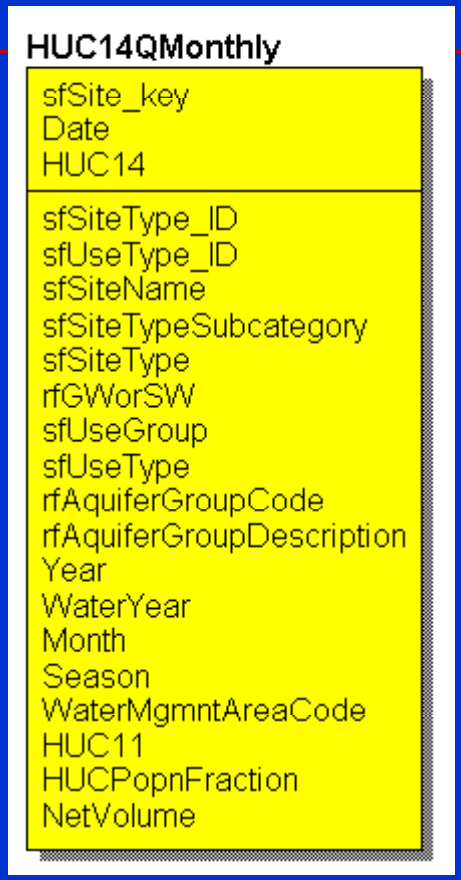
Data Marts - Simple analytical structures

From the simplified structure of the DW tables we can create customized tables for analysis.

Here we see a table of Site/HUC/Month withdrawals

The prefix ‘sf’ identifies the source records as coming from the ‘From’ Site in the conveyance model.



Each ‘datamart’ is a single table with selected fields from the DW design

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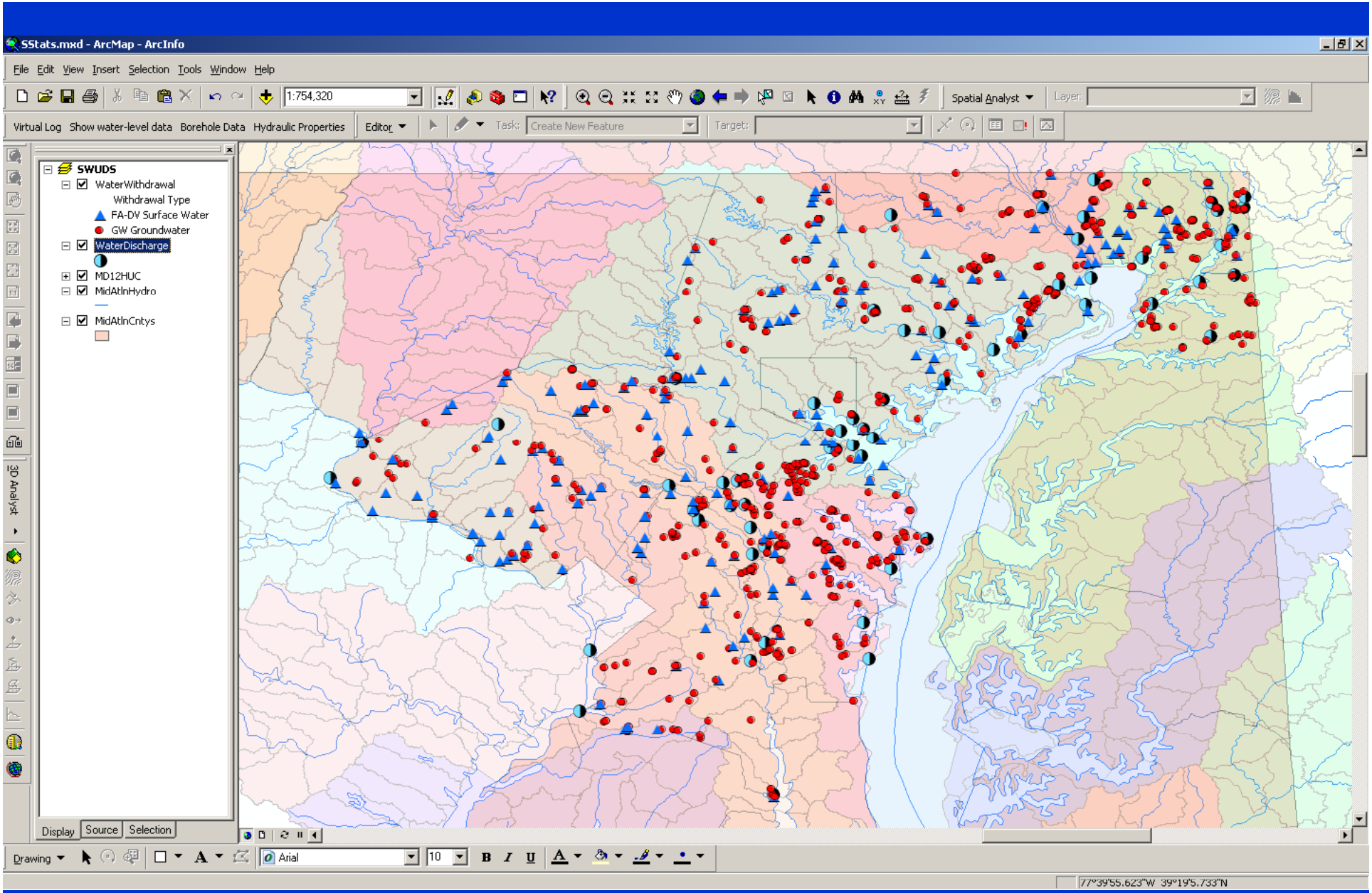

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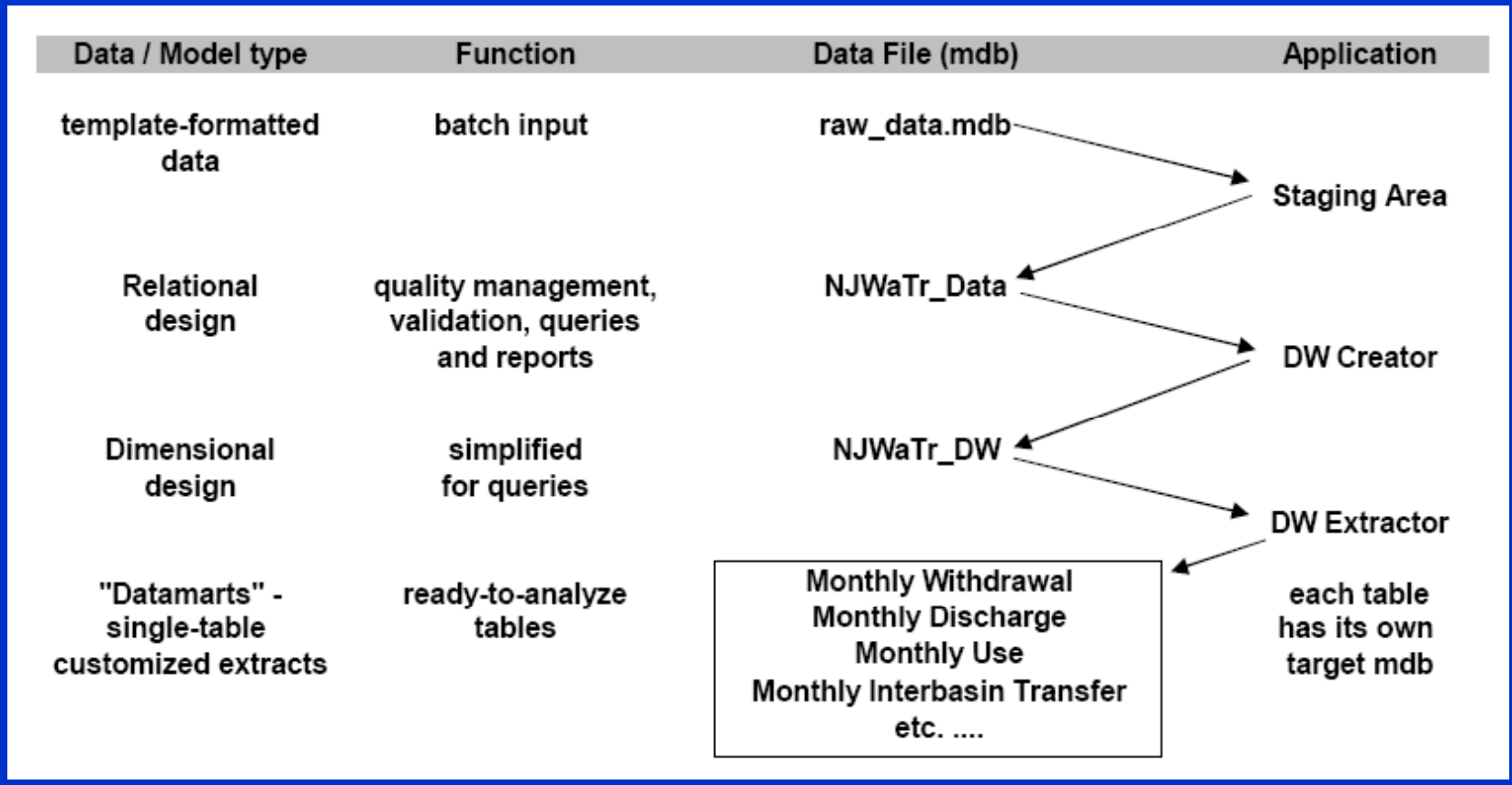
Slide courtesy of Mark Nardi, USGS

NJWaTr
New Jersey Water-Transfer Data System

The complete set of NJWaTr databases and applications are illustrated here



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** SWUDS has an application for the preparation of 'raw data' and also an import function similar to NJWaTr. SWUDS also has a program that transforms the relational structure to a star-scheme DW format for users. Mark Nardi will talk about one of the extracts made from the DW.

Components of an Ideal Water-Use Database System

1. **Conveyance-based data storage in a relational database with a dimensional (DW) companion**
   - data meet a predetermined level of completeness and quality
   - DW presents user-friendly form of the data
2. **Accepts data for 'one-sided conveyances'**
   - site-specific data usually associated with a resource-interactor site
3. **Flexible 'Location' design for partitioning of 'area' water quantities**
   - places of use, distribution/collection areas, land applications, etc.
4. **Alias system for handling naming variations**
5. **Detailed associations of Sites with hydrologic Resource features**
   - resource-interaction details, allow for compound resources

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Components of an Ideal Water-Use Data System
(cont'd)

6. **Store related Quantities that result from the use of water**
   Acres irrigated, kilowatts generated, population served

7. **Ability to incorporate or associate with Regulatory and Permit data**

What Else??

8.
9.
10.

Thanks for listening!

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