Camp Dresser & McKee Inc.

An Arcview-based Peak Flow Sanitary Sewer Model and Master Planning Tool

Goals

- Quick and visual tool for assessing existing deficiencies in the conveyance system
- Assess effects of future development.
- Allocate sewer fees according to proportional contribution of peak flows.
- Version 1 modelers tool only; Future version of program will provide full interface for end users.

Modeling Assumptions

- Simple PFRP (Peak Flow Routing Program) - peak flows computed at each pipe - all flows routed (cascaded) downstream, regardless of actual conveyance.
- Wet/Dry peak flows from flow monitoring used for minimal calibration.
- Base Wastewater Flows (BWF) based on land uses/zoning.
- I/I based on inflow units per inch-mile by I/I zone

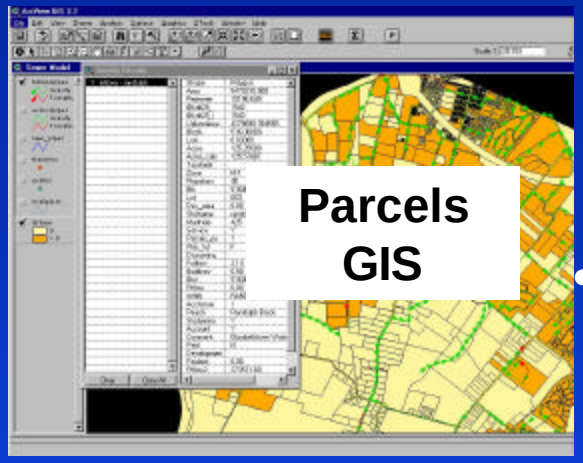
Flow Components

- BWF - Peaked by formula
- GWI - Groundwater Infiltration (not peaked)
- RDI/I- Rain-Dependent Inflow and infiltration (not peaked)
- Pump Flows - Firm capacity of Pump Station routed downstream (not peaked)
- Flow components are tracked separately through system.

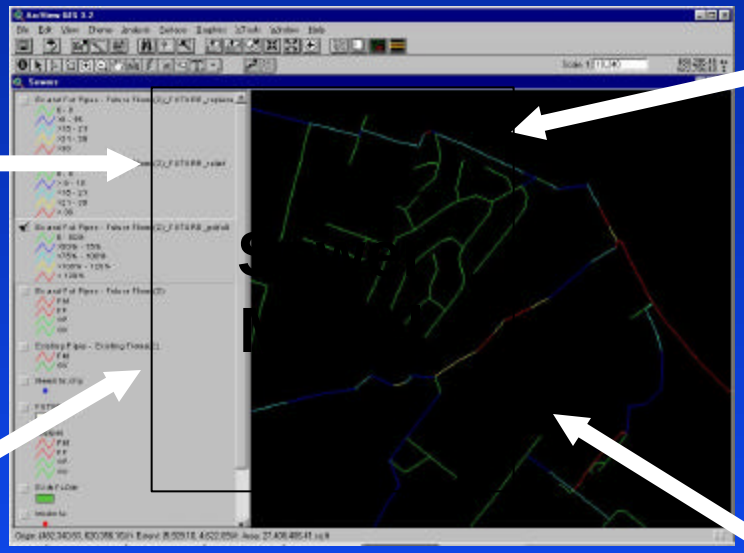
Special Considerations

- Flow Splits - for now a specified percent allocation - other rules to follow (conveyance ratio, overflow conduit, etc).
- Pump Stations - All flow influent to pump station is discarded and firm capacity of PS routed downstream (conservative assumption).

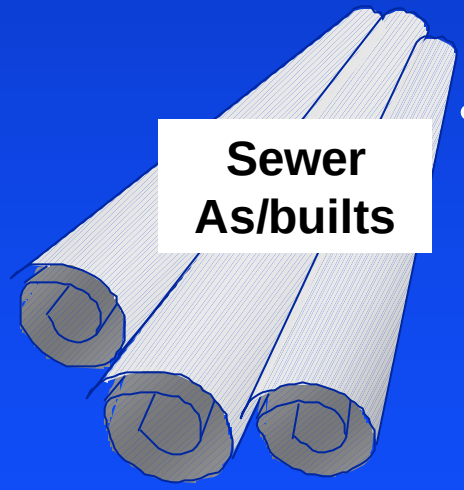
Data Sources



Parcels GIS



Design Standards



Sewer As/builts

Pump Station Capacities

Project Setup

Global Data

Define 1 or more scenarios - e.g. “Existing” and “Future”, and Edit ArcView table.

Edit ArcView table of standard pipe sizes

Edit GlobParms table - of required fields and overall modeling parameters

Global Data Tables

STD_SIZE

STD_SIZE
8
10
12
15
18
21
24
27
30
36
42
48
54
60
66
72
84
96
108
120
132
144

SCENARIOS

Scenid	Desc	Year
EXISTING	EXISTING	1998
FUTURE	FUTURE	2005

SPLIT_PIPES

Pipe_id	Splitcode	Factor
2847	D	0.50
2850	D	0.50
2651	D	0.50
2652	D	0.50

Global Data Tables

GlobParms

Key	Desc	Value
PipeFromNodeField	Field in Pipe Theme to use for 'From Node'	UPNODE
PipeToNodeField	Field in Pipe Theme to use for 'To Node'	DNNODE
PipeOrderField	Field in Pipe Theme to use for pipe order	PORDER
PipeIDField	Field in Pipe Theme to use for pipe ID	pipe_id
PipeLengthField	Field in Pipe Theme to use for pipe length	LENGTH
PipeMannField	Field in Pipe Theme to use for Manning's n	ROUGHNESS
PipeSlopeField	Field in Pipe Theme to use for pipe slope	SLOPE
PipeGWIZoneField	Field in Pipe Theme to use for GWI Zone	inttrib
PipeRDIIZoneField	Field in Pipe Theme to use for RDII Zone	inttrib
PipeYearField	Field in Pipe Theme to use for Year	YEAR
InflowAreaTableName	Table to Use for Inflows (may be linked to Polygon	ALLFLOWS
InflowAreaBWFField	Field in Inflow Area Table to use for BWF	BWF
InflowAreaAreaField	Field in Inflow Area Table to use for Area	Area
InflowAreaIDField	Field in Inflow Area Table to use for ID	blknlt25_i
InfilUnits	Use 'AC' for gpd/Ac; 'IM' for gpd/in-mi	IM
InflowAreaUnitsConv	Factor to cvt units to Ac. (.0000229568 for sf)	.0000229568
PipeDiamField	Field in Pipe Theme to use for pipe Diam	Diameter
ModelView	View Used for Sewer Modeling	Sewers
InflowAreaScenField	Field in Inflow Area Table to use for Scenario	Scenid
PumpTableName	Table to Use for Pump Inflows (may be linked to P	PUMPFLOW
PumpScenField	Field in Pump Inflows Table to use for Scenario	Scenid
PumpIDField	Field in Pump Inflows Table to use for ID	Pump_id
PumpCapacityField	Field in Pump Inflows Table for capacity (gpm)	pumpflow
InflowAreaNodeField	Field in Inflow Area Table for Node Allocation	Manhole
PumpNodeField	Field in Pump Inflows Table for Node Allocation	node_id
DesignFull	Design Percent Full for pipes (e.g. "60" for 60% f	90
RoundDown		5
PipeIsFMainField	Field in Pipe table - Is Pipe Force Main?	IsFMain

Project Setup

<u>Flow analysis and development</u>

- Flow metering - collect wet/dry peak flows at meter locations.
- Delineate sewersheds and assign parcels to nearest modeled node in sewershed.
- Assign I/I rates to zones, estimate BWF for each parcels by scenario using landuse/zoning
- Collect Pump Station Data: firm capacity under each scenario and upstream node id of force main.
- Create BWF table - one record for each parcel for each flow scenario - based on parcel GIS and flow analysis

Model Data Tables

RDII_RATES

Scenid	Rdirate	Rdizone
EXISTING	500.0000	AMWELL ROAD
EXISTING	500.0000	ATRIUM
EXISTING	500.0000	BONNER
EXISTING	500.0000	EASTON AVE
EXISTING	500.0000	INDUSTRIAL
EXISTING	500.0000	NORTH
EXISTING	500.0000	RANDOLPH BROOK
EXISTING	500.0000	RARITAN BROOK
EXISTING	500.0000	SMITH ROAD
EXISTING	500.0000	SOMERSET HILLS
EXISTING	500.0000	VAN CLEEF
EXISTING	500.0000	WORLDS FAIR DRIVE
EXISTING	500.0000	RARITAN EAST
EXISTING	500.0000	RARITAN WEST
EXISTING	500.0000	ZAREPATH
FUTURE	500.0000	AMWELL ROAD
FUTURE	500.0000	ATRIUM
FUTURE	500.0000	BONNER
FUTURE	500.0000	EASTON AVE
FUTURE	500.0000	INDUSTRIAL
FUTURE	500.0000	NORTH
FUTURE	500.0000	RANDOLPH BROOK
FUTURE	500.0000	RARITAN BROOK
FUTURE	500.0000	SMITH ROAD
FUTURE	500.0000	SOMERSET HILLS
FUTURE	500.0000	VAN CLEEF
FUTURE	500.0000	WORLDS FAIR DRIVE
FUTURE	500.0000	RARITAN EAST
FUTURE	500.0000	RARITAN WEST
FUTURE	500.0000	ZAREPATH

Model Data Tables

PUMPFLOW

Scenid	Pump_id	Pumpflow	Node_id
EXISTING	Huntington/Exxon	720000.00000	785
EXISTING	E Millstone	216000.00000	1276
EXISTING	Weston Canal	4680000.00000	11
EXISTING	Stonehenge	60480.00000	4324
EXISTING	Wilson Rd	396000.00000	963
EXISTING	Bennet's La	1000000.00000	2853
EXISTING	Amwell Rd	504000.00000	1907
EXISTING	Wildflower	316800.00000	3073
EXISTING	Van Cleef	302400.00000	2705
FUTURE	Huntington/Exxon	720000.00000	785
FUTURE	E Millstone	216000.00000	1276
FUTURE	Weston Canal	5904000.00000	11
FUTURE	Stonehenge	60480.00000	4324
FUTURE	Wilson Rd	600000.00000	963
FUTURE	Bennet's La	1000000.00000	2853
FUTURE	Amwell Rd	1100000.00000	1907
FUTURE	Wildflower	316800.00000	3073
FUTURE	Van Cleef	460800.00000	2705
FUTURE	Zarepath	2500000.00000	10120
FUTURE	Raritan	250000.00000	10007
FUTURE	Mettler's Rd	1000000.00000	10081

Model Data Tables

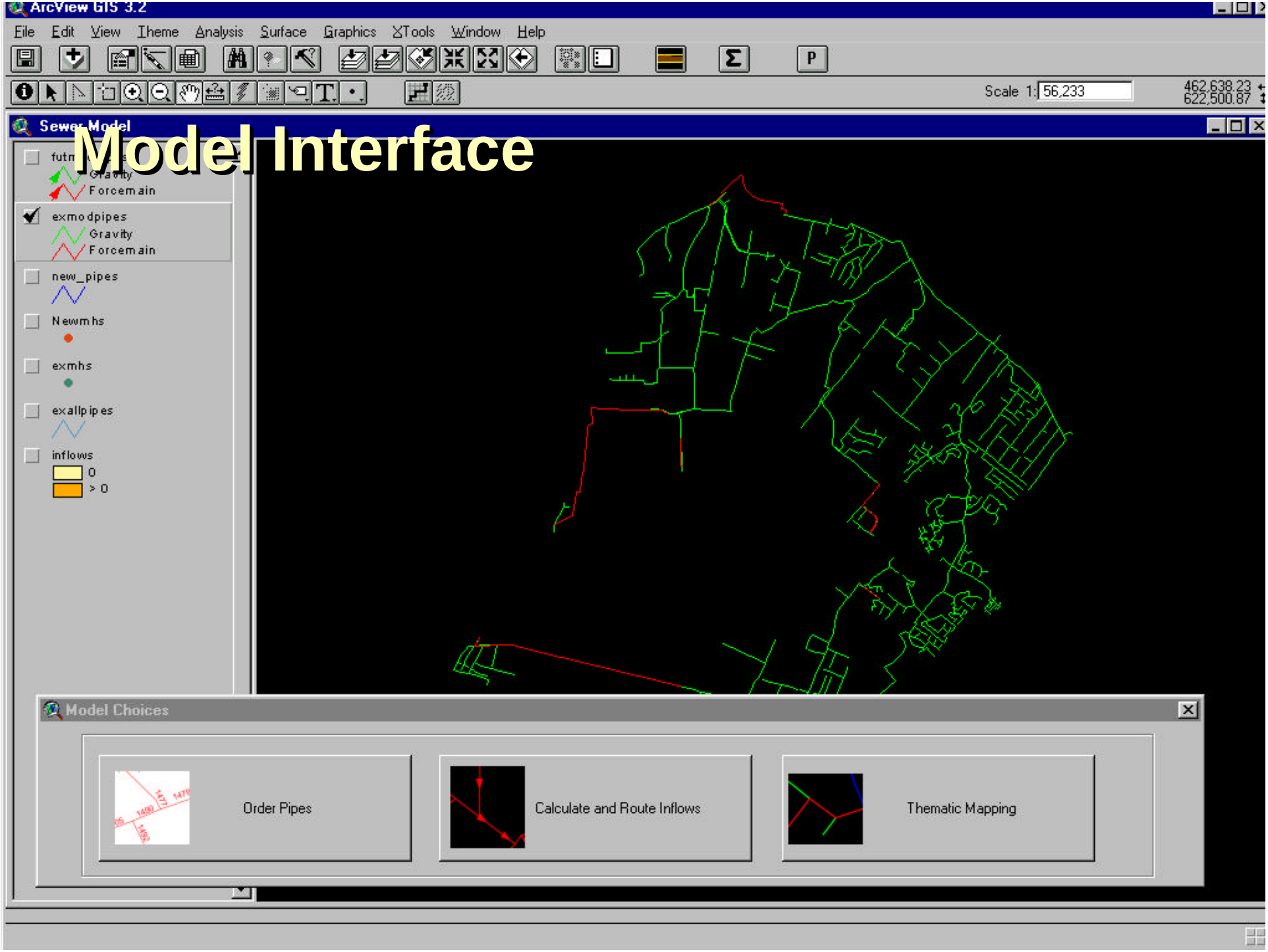
ALLFLOWS

Area	Elknlt25_i	Manhole	Elot	Ewf	Scenid
26831.445	2234	598	44700.00400	300.00	Existing
26195.281	2235	618	44700.01900	300.00	Existing
54812.281	2236	601	44300.01200	300.00	Existing
226611.844	3682	0	7500.01400	0.00	Existing
134253.563	780	23	54200.00000	225.00	Existing
132046.734	644	23	54500.00000	0.00	Existing
28763.160	3054	0	41702.00000	0.00	Existing
3850.808	3023	0	41702.00000	0.00	Existing
8664.021	3004	0	41702.00000	0.00	Existing
3740.231	2977	0	42414.00000	0.00	Existing
4014.701	2955	0	42414.00000	0.00	Existing
4507.732	2945	0	42414.00000	0.00	Existing
4329.991	2944	0	42414.00000	0.00	Existing
3583.483	2893	0	42408.00000	0.00	Existing
1993.650	2872	0	42408.00000	0.00	Existing
8386.780	2857	0	42408.00000	0.00	Existing
6372.111	2852	0	42404.00000	0.00	Existing
6953.984	2825	0	42408.00000	0.00	Existing
135.042	2824	0	42408.00000	0.00	Existing
1460.118	2816	0	42404.00000	0.00	Existing
4752.887	2787	0	42408.00000	0.00	Existing
1768.208	2779	0	42408.00000	0.00	Existing
2308.954	2735	0	42410.00000	0.00	Existing
1720.382	2728	0	42410.00000	0.00	Existing
1768.479	2585	0	42410.00000	0.00	Existing
64644.590	2268	0	42402.00000	0.00	Existing
58061348.000	2	0	9999999.90000	0.00	Existing
5317.129	2796	0	42408.00000	0.00	Existing
418362.125	2757	767	42408.06300	13500.00	Existing
63948.145	4479	0	9999999.90000	0.00	Existing
293223.906	4478	0	300.00000	0.00	Existing
334386.281	4477	0	400.00000	0.00	Existing
56175.176	4476	0	200.00000	0.00	Existing
376781.938	4475	0	501.00000	0.00	Existing

Model Interface - Version 1

- Required Tables
- Pipes Theme - required fields
- Dialog and UI button
- MOD_FLOWS Table for results - empty at first

Model Interface



Model Operation

- Pipe ordering routine
- Flow routing
- Thematic mapping

Pipe Ordering Routine

- Note: requires that pipes have node1 and node2 id fields - uses GlobParms to identify fields
- Identify “outfalls” and verify before proceeding
- Start from each “outfall” and number upstream, putting branches on stack to number later.
- Guarantees that for any numbered pipe, all upstream pipes will have higher numbers.

Flow Routing Routine:

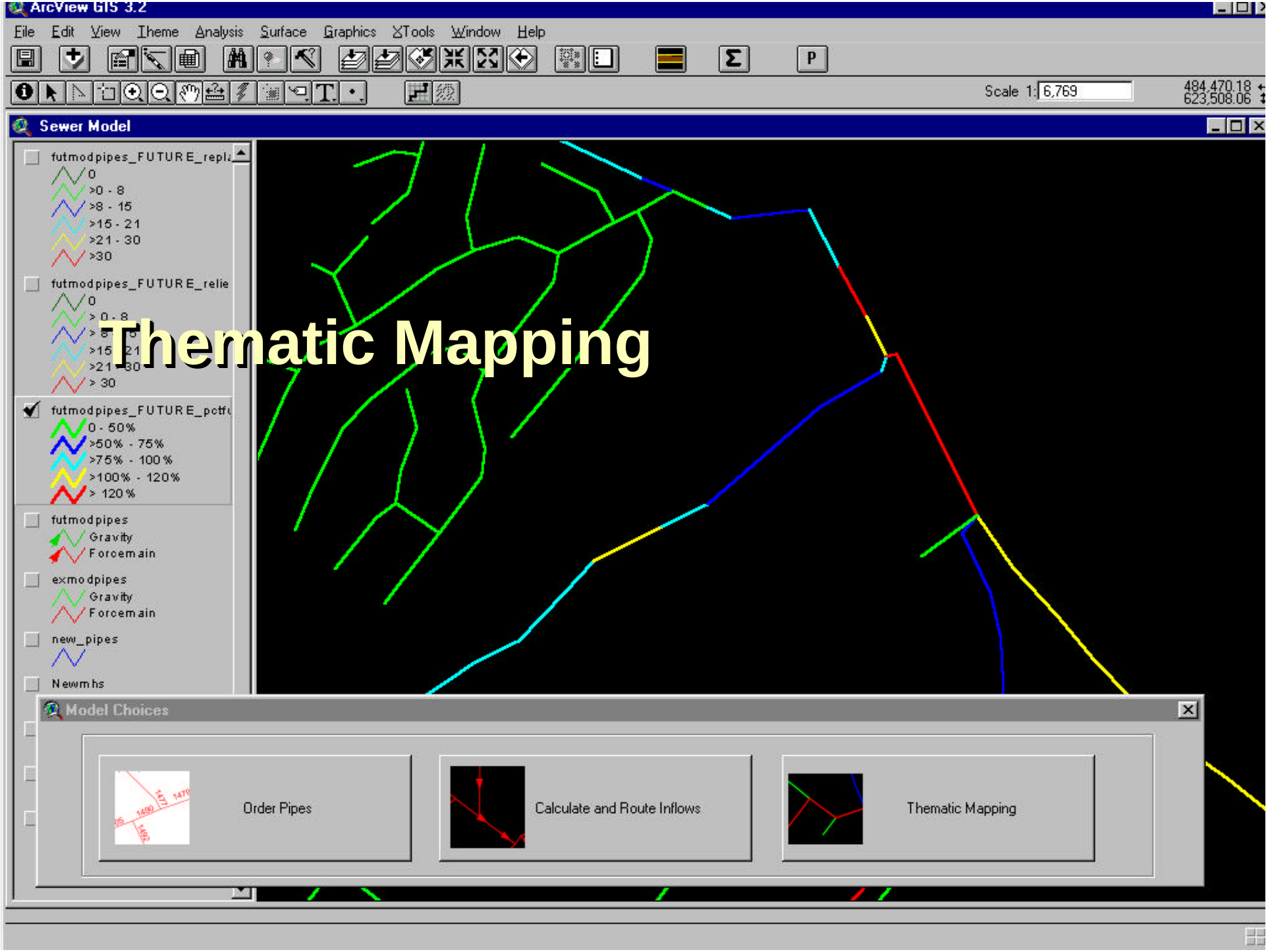
User selects pipe theme, scenario(s) to model

Program reads Globparms and constructs a dictionary from it.

For each scenario; for each pipe:

Routine collects inflows at upstream node; Collects flow data from upstream pipes (by querying MOD_FLOW table); computes flow and capacity characteristics of current pipe, and writes results to MOD_FLOW.

Next pipe; next scenario
(refer to technical summary for details)



Thematic Mapping

Proportional Share Allocation

After modeling has identified capital improvement projects, a table of projects and the downstream-most pipe ID of each project is constructed.

PROJECTS

Project_id	Projdspipe
Hollywood	2469
Bonner-Easton	2453
Sunnyvale	2435
Bonner-12th	2423
Bonner-Ukr Vil	2415
Bonner-Willow	1213
Bonner-New Bruns	3797
Bonner-Wilson	3929
Wilson Rd	1135
Bonner-Martino	1118
Bonner-Mindel B	1113
Bonner-Dermott	1122
Bennetts	3628
Amwell	3285
Van Cleef	3581
Wildflower	3583
Millstone	3707
Cedar Grove	2459
Worlds Fair	2585
Atrium	2630
Atrium South	2617
287-Easton	2945
Raritan Brook	2657
Raritan Brook W	10120
Raritan Brook E	10121
Elizabeth	10118
Industrial	2666
Belmont	2817
School House	2721
Exxon/Bio	1194
Somerset Hills	2937
Weston Canal	2852
Campus	2767
Randolph Brook	2766
Zarapath N	10119

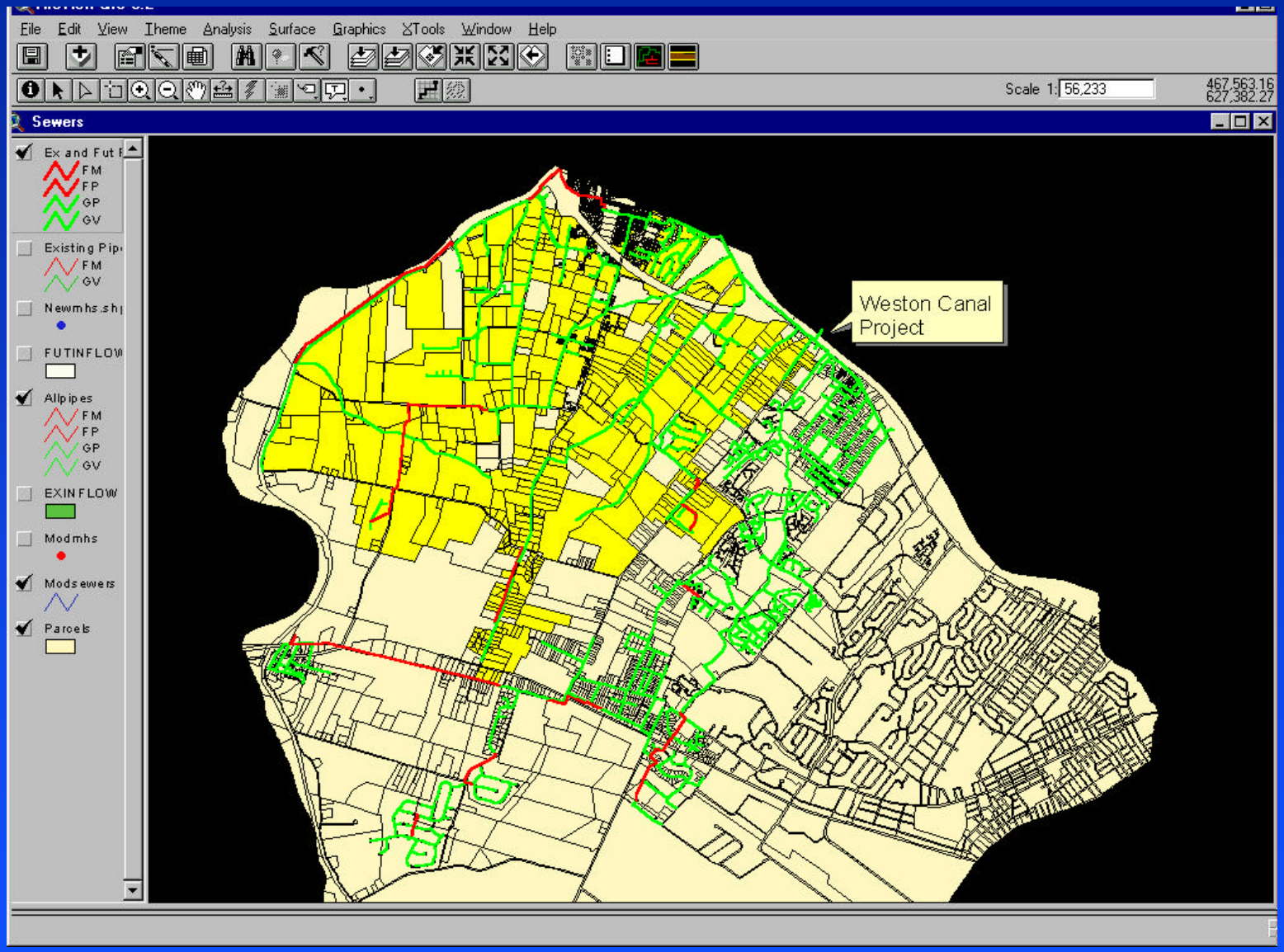
Proportional Share Allocation

For each Identified project, the allocation routine traces upstream through the network to identify all upstream loadpoint nodes and the parcels that load to them under the specified flow scenario. A table of upstream nodes and parcels for each project is generated.

PROJPARCELS

Project_id	Inflownode	Parcels_id	Parcels_nu
Weston Canal Rd	344	1421	1421
Weston Canal Rd	344	1457	1457
Weston Canal Rd	344	1534	1534
Weston Canal Rd	366	1496	1496
Weston Canal Rd	366	1542	1542
Weston Canal Rd	366	1554	1554
Weston Canal Rd	384	1517	1517
Weston Canal Rd	384	1572	1572
Weston Canal Rd	384	1590	1590
Weston Canal Rd	384	1597	1597
Weston Canal Rd	384	1609	1609
Weston Canal Rd	404	1549	1549
Weston Canal Rd	404	1557	1557
Weston Canal Rd	404	1649	1649
Weston Canal Rd	404	1670	1670
Weston Canal Rd	431	1568	1568
Weston Canal Rd	431	1665	1665
Weston Canal Rd	431	1692	1692
Weston Canal Rd	431	1710	1710
Weston Canal Rd	431	1711	1711
Weston Canal Rd	431	1724	1724
Weston Canal Rd	431	1737	1737
Weston Canal Rd	431	1756	1756
Weston Canal Rd	431	1776	1776
Weston Canal Rd	431	1783	1783
Weston Canal Rd	431	1793	1793
Weston Canal Rd	431	1834	1834
Weston Canal Rd	431	1908	1908
Weston Canal Rd	431	2043	2043
Weston Canal Rd	272	1357	1357
Weston Canal Rd	185	1260	1260
Weston Canal Rd	207	1279	1279
Weston Canal Rd	269	1342	1342
Weston Canal Rd	266	1337	1337
Weston Canal Rd	334	1464	1464

Proportional Share Allocation



Proportional Share Allocation

The upstream parcels table is joined with the parcels table to obtain base flows for the appropriate scenario, and the joined table is exported for analysis in Excel.

PROJPARCELS

Project_id	Inflownode	Parcels_id	Parcels_nu
Weston Canal Rd	344	1421	1421
Weston Canal Rd	344	1457	1457
Weston Canal Rd	344	1534	1534
Weston Canal Rd	366	1496	1496
Weston Canal Rd	366	1542	1542
Weston Canal Rd	366	1554	1554
Weston Canal Rd	384	1517	1517
Weston Canal Rd	384	1572	1572
Weston Canal Rd	384	1590	1590
Weston Canal Rd	384	1597	1597
Weston Canal Rd	384	1609	1609
Weston Canal Rd	404	1549	1549
Weston Canal Rd	404	1557	1557
Weston Canal Rd	404	1649	1649
Weston Canal Rd	404	1670	1670
Weston Canal Rd	431	1568	1568
Weston Canal Rd	431	1665	1665
Weston Canal Rd	431	1692	1692
Weston Canal Rd	431	1710	1710
Weston Canal Rd	431	1711	1711
Weston Canal Rd	431	1724	1724
Weston Canal Rd	431	1737	1737
Weston Canal Rd	431	1756	1756
Weston Canal Rd	431	1776	1776
Weston Canal Rd	431	1783	1783
Weston Canal Rd	431	1793	1793
Weston Canal Rd	431	1834	1834
Weston Canal Rd	431	1908	1908
Weston Canal Rd	431	2043	2043
Weston Canal Rd	272	1357	1357
Weston Canal Rd	185	1260	1260
Weston Canal Rd	207	1279	1279
Weston Canal Rd	269	1342	1342
Weston Canal Rd	266	1337	1337

Future Enhancements

- Scenario Management.
- Expanded Flow Split rules.
- Better end-user tools and automation of tasks
- Alternatives for routing pump flows.
- Support for maintaining multiple versions of pipes by date in the GIS.

What Can Object-Oriented GIS Provide for Sewer Modelers?

- Versioning - provide multiple versions of physical network depending on date (time dimension), and alternative future configurations.
- Intelligent links between network elements and linked objects - e.g. edit polygons and automatically propagate changes throughout flow model.
- Objects (like Pumps) that incorporate complex behavior rules.
- Suggestions?