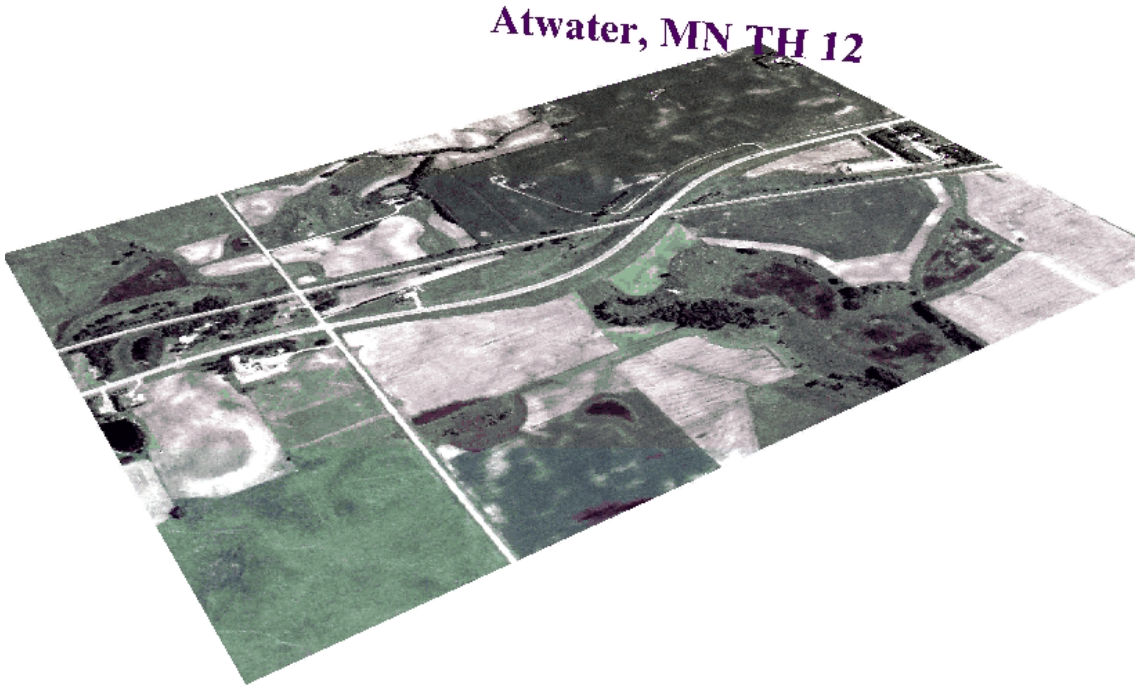
3D Visualization of Intelligent Compaction Data



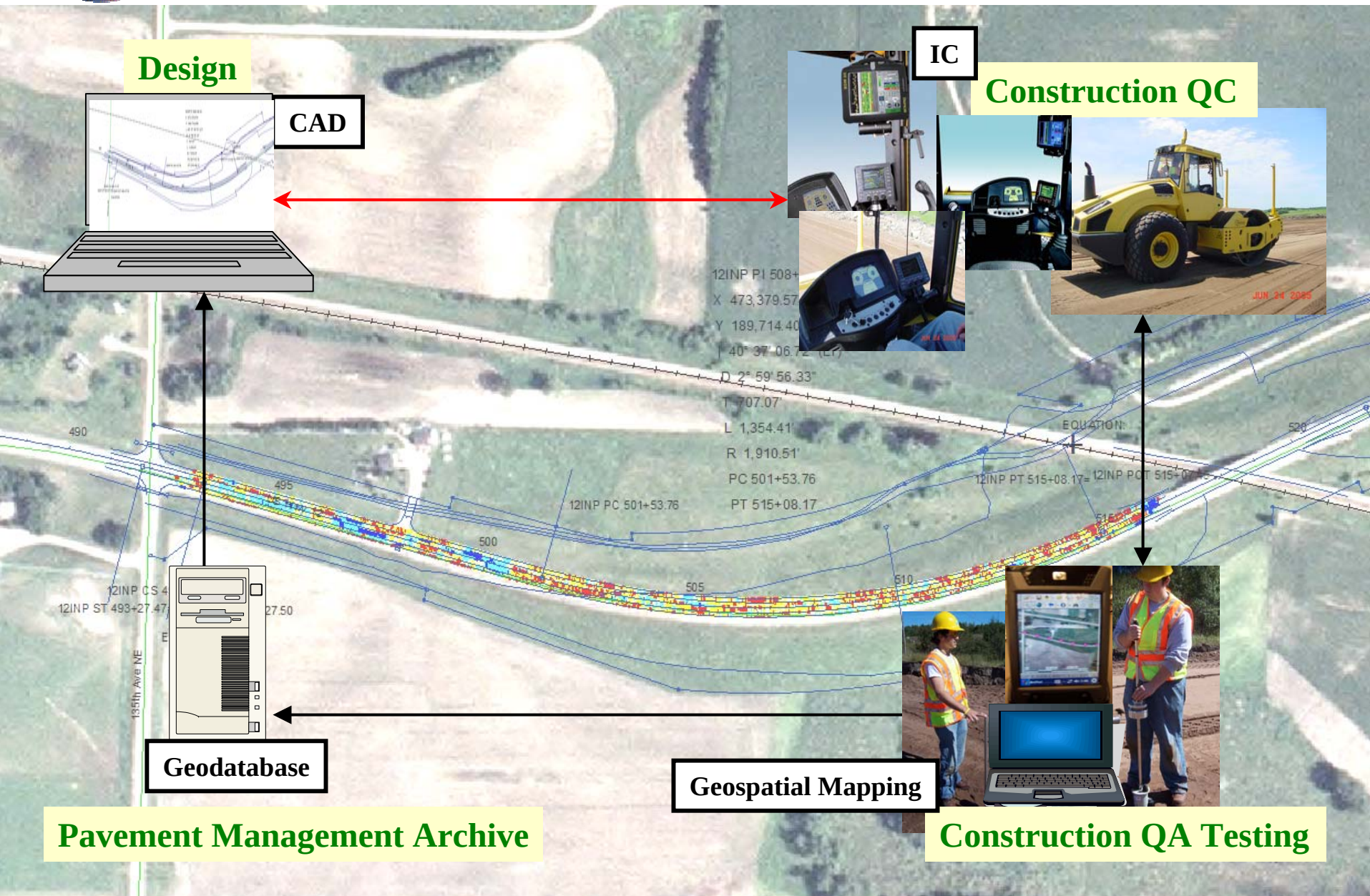
Ruth Roberson

Minnesota Department of Transportation

Transportation Research Conference

May 24-25, 2006

St Paul, Minnesota


Design
CAD
IC
Construction QC
Geodatabase
Geospatial Mapping
Pavement Management Archive
Construction QA Testing
12INP PI 508+
X 473,379.57
Y 189,714.40
D 2° 59' 56.33"
T 707.07'
L 1,354.41'
R 1,910.51'
PC 501+53.76
PT 515+08.17
12INP PC 501+53.76
12INP PT 515+08.17
EQUATION:
12INP CS 4
12INP ST 493+27.47
27.50
135th Ave NE
490
495
500
505
510
515
520

Current Mn/DOT QC/QA

- Sand cone testing
  - 100% Proctor
- Test rolling
- Oven-dry MC

Problems

- Slow results
- Inaccurate
- Tests / verifies empirical parameter
- Unsafe!

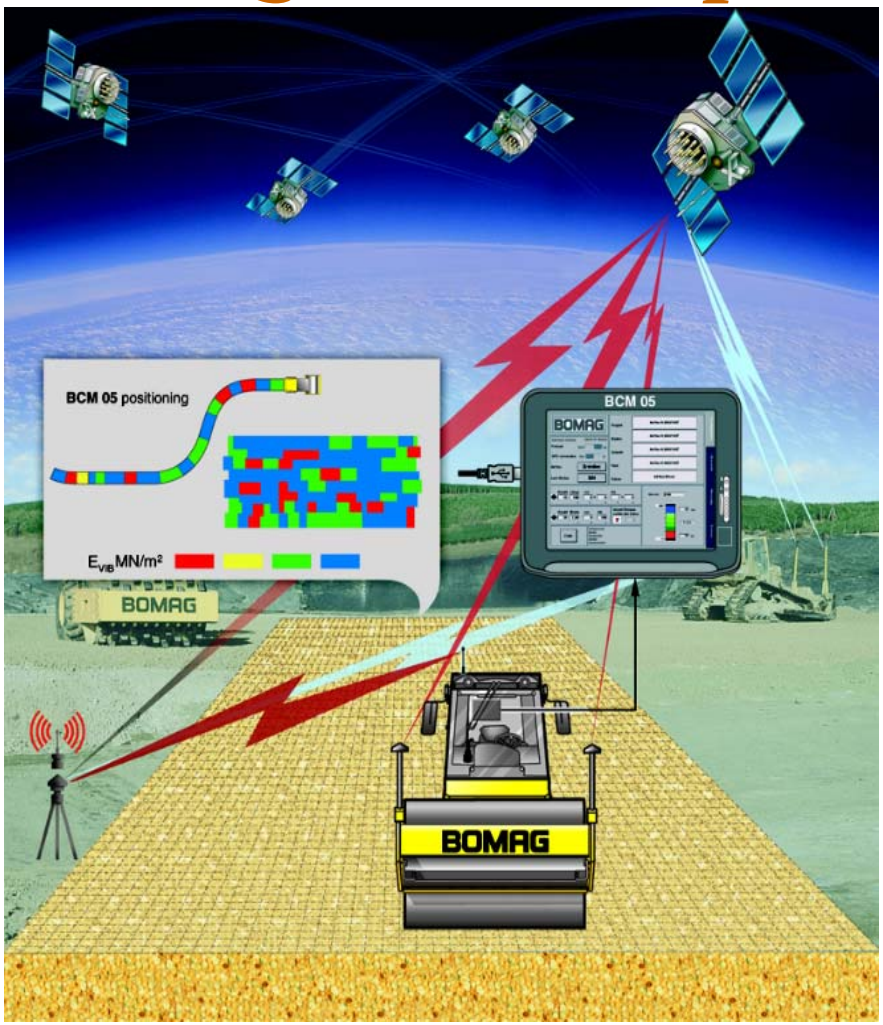
Mechanistic Testing Equipment

- Elastic Modulus
  - Intelligent Compactor (IC)
  - Plate Load Tests (static and quasi-static)
  - Falling Weight Deflectometer (FWD)
  - Light Weight Deflectometer (LWD)
  - Soil Stiffness Gauge (SSG or GeoGauge)
- Shear Strength
  - Dynamic Cone Penetrometer (DCP)

Intelligent Compaction in Minnesota

- The Minnesota Department of Transportation has been investigating intelligent compaction (IC) technology over the past two years.

Intelligent Compaction



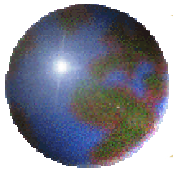
- **Continuous calculation of compaction or related parameter**
- **Automatic adjustment of compactive effort in response to measured material parameter**
- **Documentation system that provides on-demand color coded mapping of the site**

Benefits to Mn/DOT

- Increased Compaction Uniformity
- Complete Documentation of Every Lift
- Automation and Better Record Keeping
- Improved Inspector Safety
- No More Sand Cone Testing

2005 Conclusions

- The compactors were well made, easy to operate, and helped the operator to make better decisions.
- Intelligent compactors can measure the stiffness of the ground and adjust their compactive force as needed.
- Surface covering documentation can be produced.
- Data transfer was functional, but must be improved.



How We Handle the Data?

IC Roller Similarities

- Single drum vibratory rollers
- GPS System
- Stiffness / Modulus estimated
- Mapping System

IC Roller Differences

- Geographic Positioning System (GPS)
- Data File Format and Information
  - Coordinate and Projection System
  - Timestamp
  - Manufacturer Specific Output (Passes)

Field QA Inspection ***Implementation***

- Technologically “Easy” to Use
  - Handling the data
- Field Rugged
  - Palm pilot
  - laptop
- Scientifically Rigorous
  - Preprocessing geostatistics

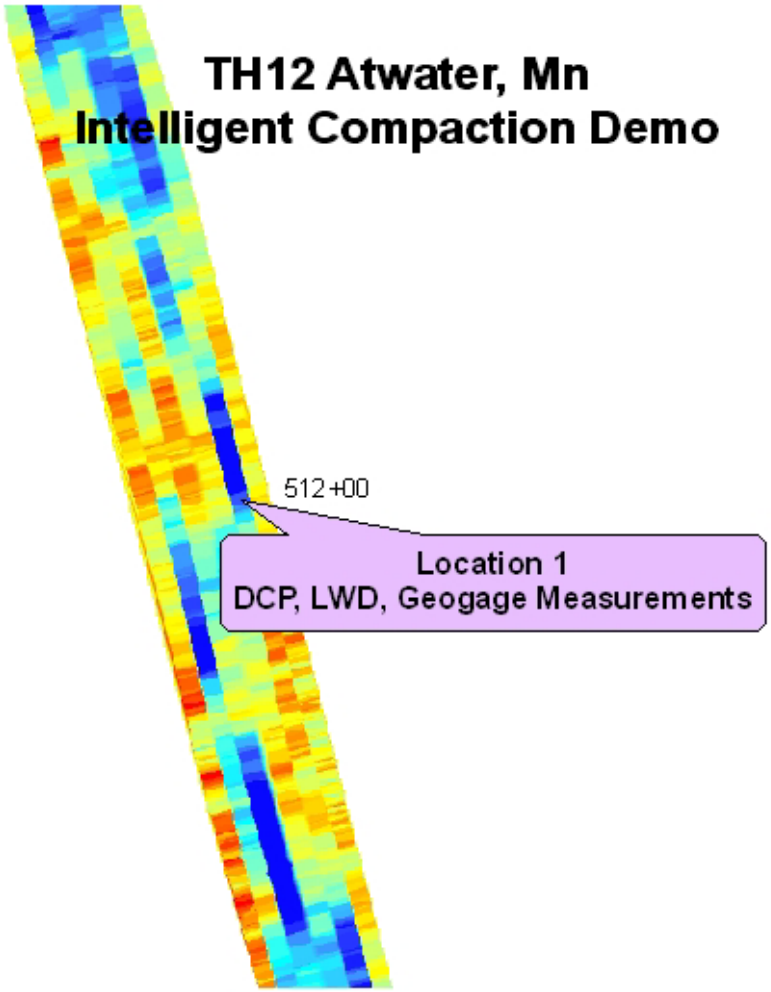
Data Needs *for Identifying Quality Assurance Test Locations.*

- Mapping system
  - Import compactor data as it becomes available.
  - Superimpose compactor data on construction plans.
- Final Compaction Layer (Proof Layer)
  - Coordinates (x,y)
  - Stiffness / Modulus estimated
  - Timestamp
- Inspection Points
  - Engineering judgement
  - Use new material specifications and geostatistical methods to determine locations for quality assurance testing.

IC Roller Data

GPS timestamp	GPS	Latitude	Longitud	Y (ft.)	X (ft.)	Z(ft)	elevation	spee	heading	heading	pass	fpsi	rpsi	epsi	pitch	roll	GCMV	GRMV	Gfreq	Gam	Geo V	Efflow	Erflow	EfPp	ErPp	EGPp	ESlopePp	EIPp	ENetP
9/28/2005 7:09	4.0	46.8	92.1	0.0	0.0	0.0	1264.2	1.2	278.9	284.9	1.0	5052.3	4709.4	0.0	4.5	0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.0	17449.0	16725.0	34174.0	3383.9	-1141.9	31.9
9/28/2005 7:09	4.0	46.8	92.1	0.0	-1.0	0.0	1264.3	2.0	279.2	283.7	1.0	4318.4	4054.1	0.0	5.9	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.0	24715.2	23859.2	48574.4	7428.7	2490.8	38.7
9/28/2005 7:09	4.0	46.8	92.1	0.0	-1.0	0.0	1264.3	2.4	296.3	286.7	1.0	3476.3	3234.9	0.0	7.0	-0.2	0.1	0.1	0.1	0.4	0.0	0.0	0.0	23554.6	22539.5	46094.1	10413.8	4175.5	31.5
9/28/2005 7:09	4.0	46.8	92.1	0.0	-1.0	0.0	1264.2	2.4	290.2	287.5	1.0	2704.1	2530.1	0.0	7.7	-0.2	0.1	0.1	0.1	0.4	0.0	0.0	0.0	18322.5	17628.2	35950.6	11453.0	4175.5	20.3
9/28/2005 7:09	4.0	46.8	92.1	0.0	-2.0	0.0	1264.2	2.5	287.0	287.4	1.0	2150.9	2039.0	0.0	8.3	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	15281.7	14896.1	30177.8	12853.0	4702.0	12.6
9/28/2005 7:09	4.0	46.8	92.1	1.0	-2.0	0.1	1264.2	2.6	295.7	289.5	1.0	1996.0	1966.1	0.0	7.9	-0.6	0.1	0.1	0.1	0.4	0.0	0.0	0.1	14706.4	14896.2	29602.6	12717.1	5123.2	11.8
9/28/2005 7:09	4.0	46.8	92.1	1.0	-2.0	0.1	1264.2	2.8	293.3	290.6	1.0	1995.4	1966.4	0.0	7.3	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	16211.7	16428.1	32639.8	12993.3	6334.1	13.3
9/28/2005 7:09	4.0	46.8	92.1	1.0	-3.0	0.0	1264.2	2.5	286.8	289.6	1.0	1886.7	1873.3	0.0	6.7	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13652.4	13939.4	27591.9	10517.5	4912.6	12.2
9/28/2005 7:09	4.0	46.8	92.1	1.0	-3.0	0.0	1264.2	3.0	295.1	291.3	1.0	1761.6	1761.6	0.0	6.0	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	14891.7	15313.0	30204.7	11051.8	6860.6	12.3
9/28/2005 7:09	4.0	46.8	92.1	1.0	-3.0	0.0	1264.2	2.8	287.6	290.3	1.0	1663.0	1647.4	0.0	5.4	-0.2	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13237.5	13483.8	26721.2	9314.9	6070.9	11.3
9/28/2005 7:09	4.0	46.8	92.1	1.0	-4.0	0.0	1264.2	2.8	280.8	287.6	1.0	1607.6	1621.5	0.0	4.7	0.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12955.1	13437.0	26392.1	8361.9	6228.8	11.8
9/28/2005 7:09	4.0	46.8	92.1	1.0	-4.0	0.0	1264.2	2.9	289.6	288.2	1.0	1536.5	1546.1	0.0	4.3	0.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12887.8	13335.0	26222.7	7811.3	6	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-5.0	0.1	1264.2	3.0	286.1	287.6	1.0	1468.4	1448.4	0.0	3.9	0.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12509.2	12687.8	25197.0	7343.8	6	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-5.0	0.0	1264.2	2.7	284.5	286.7	1.0	1473.0	1507.2	0.0	3.3	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11531.3	12133.1	23664.3	5898.6	5861	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-5.0	0.0	1264.2	2.8	285.7	286.4	1.0	1628.8	1645.9	0.0	2.7	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12911.4	13416.2	26327.7	4706.6	6018.2	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-6.0	0.0	1264.2	2.7	283.4	285.6	1.0	1758.7	1800.5	0.0	2.4	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13652.3	14372.0	28024.3	3094.2	5750.0	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-6.0	0.0	1264.3	2.9	280.3	284.1	1.0	1792.7	1784.8	0.0	2.0	-1.2	0.1	0.1	0.1	0.4	0.0	0.0	0.1	14741.3	15092.2	29833.5	3586.5	6492.0	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-7.0	0.0	1264.3	2.7	285.1	284.4	1.0	1766.6	1777.3	0.0	1.7	-1.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13771.2	14246.9	28018.1	2913.5	5807.6	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-7.0	0.0	1264.3	3.2	290.1	286.2	1.0	1699.9	1698.7	0.0	1.8	-1.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	15319.9	15742.6	31062.5	3504.8	7755.6	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-7.0	0.0	1264.3	2.9	286.9	286.4	1.0	1599.8	1615.2	0.0	1.9	-2.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13155.1	13657.3	26812.3	3374.9	6492.0	
9/28/2005 7:09	4.0	46.8	92.1	2.0	-8.0	0.0	1264.2	2.9	286.9	286.4	1.0	1435.3	1464.6	0.0	2.0	-2.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11802.6	12384.3	24186.8	3539.7	6492.0	
9/28/2005 7:09	4.0	46.8	92.1	3.0	-8.0	0.0	1264.2	3.3	295.8	289.5	1.0	1159.7	1133.0	0.0	2.1	-2.5	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10986.1	11037.0	22023.0	3321.5	6492.0	
9/28/2005 7:09	4.0	46.8	92.1	3.0	-9.0	0.0	1264.2	2.8	289.5	289.5	1.0	979.0	1021.7	0.0	1.9	-1.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	7825.1	8396.9	16222.0	3328.0	6123.5	6.8
9/28/2005 7:09	4.0	46.8	92.1	3.0	-9.0	0.0	1264.3	2.9	279.8	286.7	1.0	1076.2	1089.5	0.0	1.6	-1.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	8814.2	9175.9	17990.1	2934.9	6439.4	8.6
9/28/2005 7:09	4.0	46.8	92.1	3.0	-10.0	0.0	1264.3	2.9	284.7	286.1	1.0	1252.0	1274.0	0.0	1.3	-1.6	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10459.8	10945.1	21404.9	2366.3	6702.6	12.3
9/28/2005 7:09	4.0	46.8	92.1	3.0	-10.0	0.0	1264.3	2.8	288.6	286.8	1.0	1375.3	1389.8	0.0	0.9	-1.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11037.4	11469.4	22506.8	1666.7	6176.2	14.7
9/28/2005 7:09	4.0	46.8	92.1	3.0	-10.0	0.0	1264.2	2.8	284.9	286.3	1.0	1447.2	1481.7	0.0	0.7	-2.2	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11424.4	12027.8	23452.2	1163.1	5965.6	16.3
9/28/2005 7:09	4.0	46.8	92.1	3.0	-11.0	##	1264.3	2.8	284.1	285.7	1.0	1424.9	1431.0	0.0	0.6	-2.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11482.4	11857.7	23340.1	1093.5	6228.8	16.0
9/28/2005 7:09	4.0	46.8	92.1	3.0	-11.0	##	1264.3	2.9	290.9	287.2	1.0	1377.0	1381.6	0.0	0.7	-2.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11413.7	11776.2	23189.9	1253.9	6397.3	15.3
9/28/2005 7:09	4.0	46.8	92.1	4.0	-12.0	0.0	1264.3	2.9	289.6	287.9	1.0	1369.2	1377.9	0.0	0.8	-2.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11393.8	11790.7	23184.5	1454.2	6650.0	15.1
9/28/2005 7:09	4.0	46.8	92.1	4.0	-12.0	##	1264.3	2.8	285.3	287.2	1.0	1310.9	1339.9	0.0	0.9	-2.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10649.9	11193.6	21843.5	1616.0	6334.1	13.9
9/28/2005 7:09	4.0	46.8	92.1	4.0	-12.0	##	1264.3	2.9	287.8	287.3	1.0	1252.0	1269.1	0.0	0.9	-3.0	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10542.1	10988.6	21530.7	1745.0	6807.9	13.0
9/28/2005 7:09	4.0	46.8	92.1	4.0	-13.0	##	1264.3	2.8	292.3	288.8	1.0	1171.0	1198.3	0.0	1.0	-3.0	0.1	0.1	0.1	0.4	0.0	0.0	0.1	9514.0	10011.0	19525.0	1717.8	6334.1	11.5
9/28/2005 7:09	4.0	46.8	92.1	4.0	-13.0	0.0	1264.3	3.1	293.4	290.2	1.0	1143.8	1151.9	0.0	0.9	-3.0	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10120.1	10480.4	20600.5	1828.1	7492.4	11.3
9/28/2005 7:09	4.0	46.8	92.1	4.0	-14.0	##	1264.3	2.8	289.9	290.1	1.0	1153.9	1183.8	0.0	0.9	-3.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	9185.2	9689.6	18874.8	1595.9	6070.9	11.2
9/28/2005 7:09	4.0	46.8	92.1	4.0	-14.0	##	1264.3	3.1	285.1	288.5	1.0	1238.3	1250.2	0.0	0.9	-2.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11079.0	11501.9	22581.0	1849.3	7650.3	13.1
9/28/2005 7:09	4.0	46.8	92.1	5.0	-14.0	##	1264.3	3.0	287.2	288.1	1.0	1269.1	1321.6	0.0	0.9	-2.5	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10811.5	11577.3	22388.8	1758.7	6965.9	13.7
9/28/2005 7:09	4.0	46.8	92.1	5.0	-15.0	##	1264.3	3.1	286.1	287.5	1.0	1264.5	1270.0	0.0	1.0	-2.5	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11354.2	11726.4	23080.6	1960.7	7029.3	13.4
9/28/2005 7:09	4.0	46.8	92.1	5.0	-15.0	##	1264.3	2.9	285.9	287.0	1.0	1209.9	1235.2	0.0	0.9	-2.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10188.0	10694.7	20882.7	1684.9	6807.9	12.4

TH12 Atwater, Mn
Intelligent Compaction Demo



Implementing Simplified QA Method

- **Development Framework**
- ASCII text file (as defined by MnDOT IC specification)
- Histogram
- Linear Model for Surface Plot
- Engineering Judgment

Implementing Simplified QA Method

PositionX	PositionY	PositionZ	EVIB
57944.01	143812.1	380.062	36
57944.11	143812.1	380.062	36
57943.91	143812.2	380.073	58
57944.01	143812.2	380.073	58
57944.11	143812.2	380.062	36
57944.21	143812.2	380.062	36
57944.31	143812.2	380.062	36
57943.91	143812.3	380.08	58
57944.01	143812.3	380.073	58
57944.11	143812.3	380.073	58
57944.21	143812.3	380.073	58
57944.31	143812.3	380.062	36
57944.41	143812.3	380.062	36
57944.51	143812.3	380.062	36
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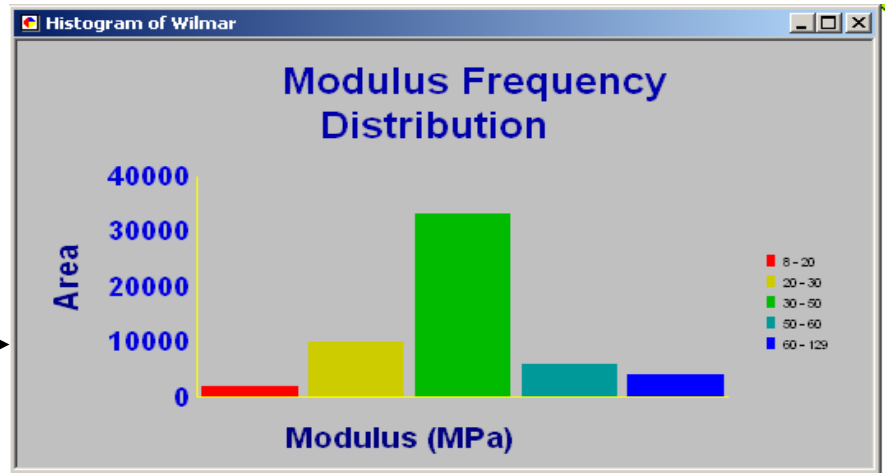
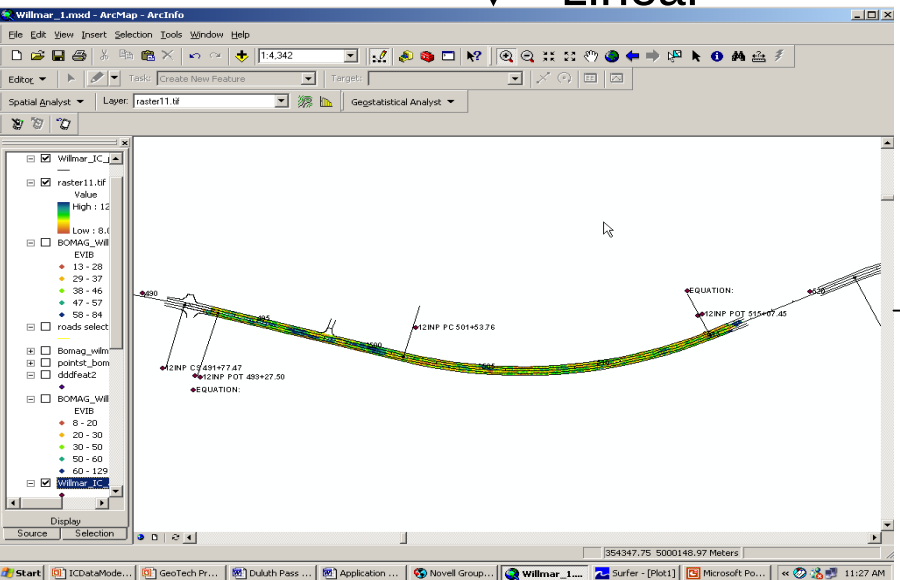
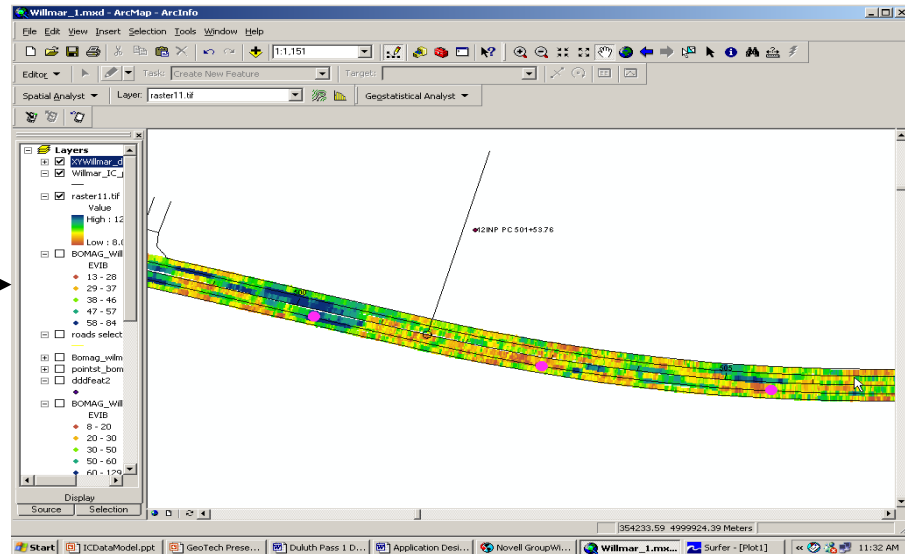
57944.01	143812.4	380.08	58



Linear

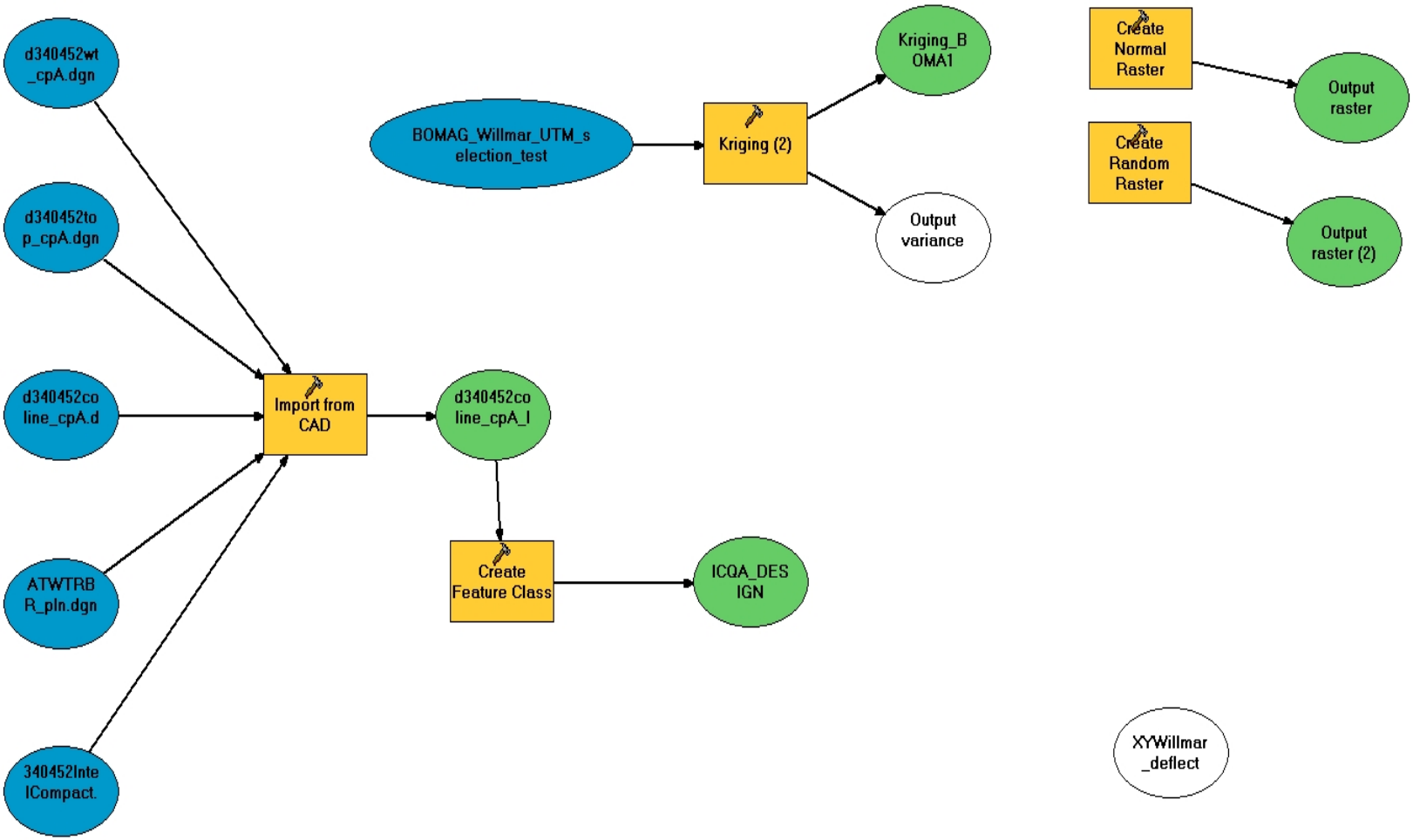


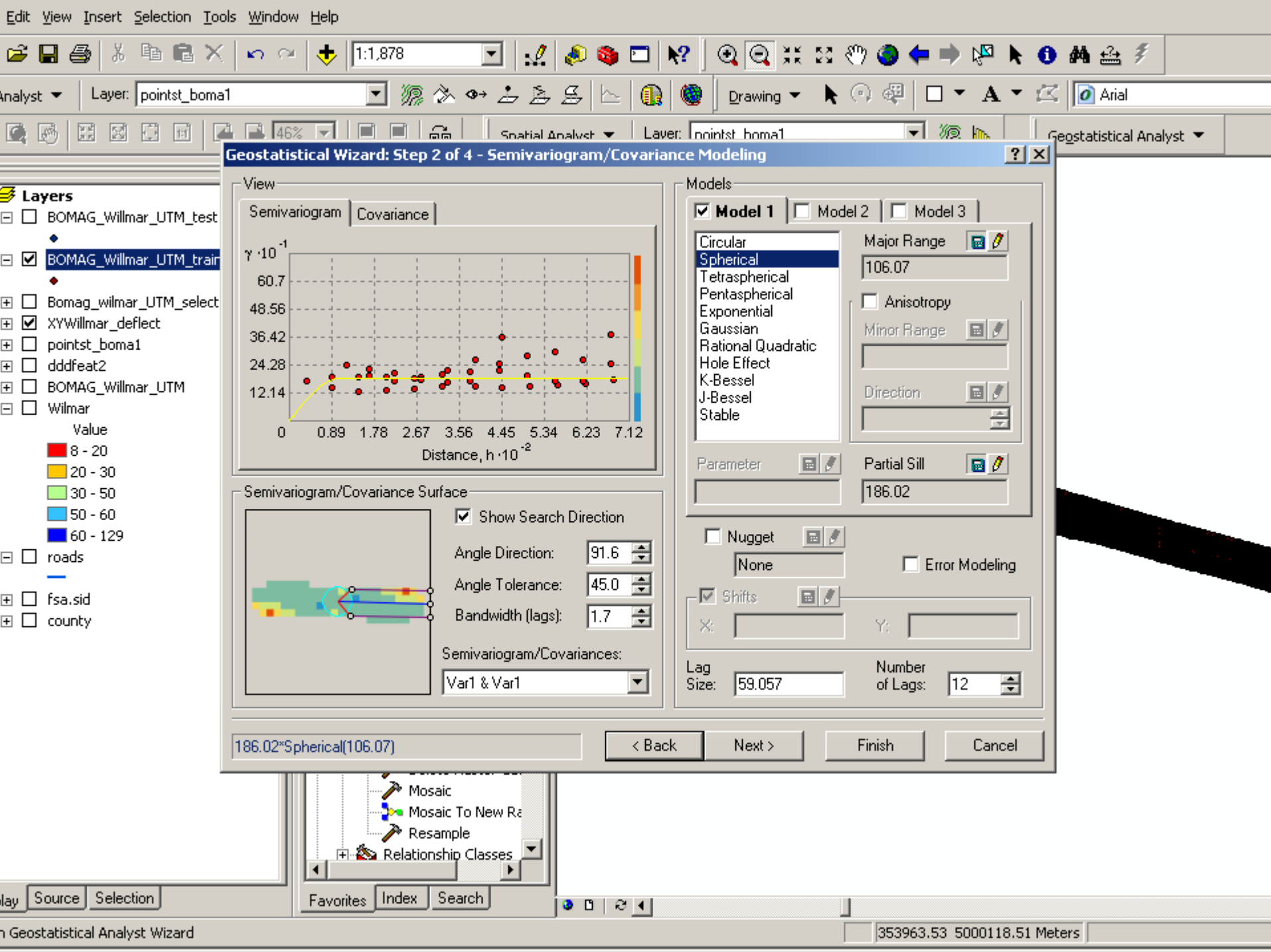


Implementing Geostatistically-Based QA Testing

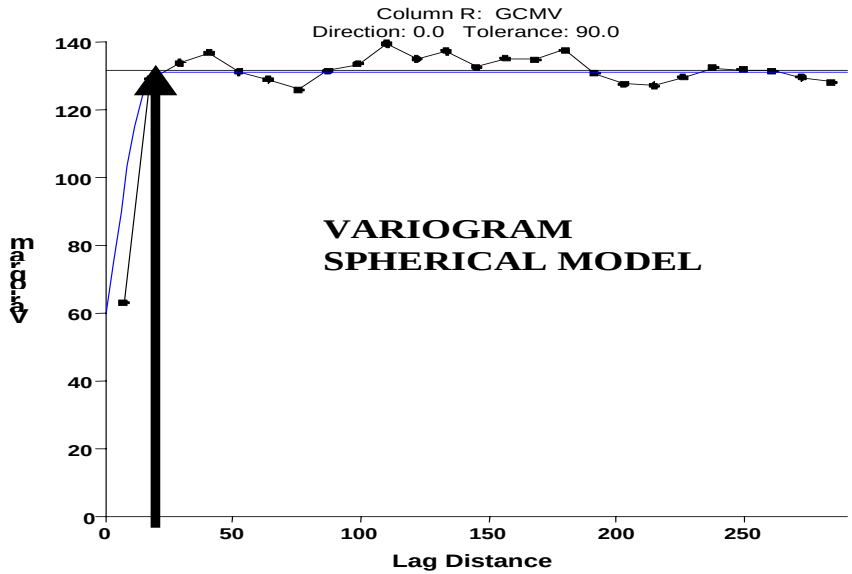
- **Development Framework**
- ASCII text file (as defined by MnDOT IC specification)
- Generate Variogram
  - Based on greatest lag distance with least amount of variability
- Final output is Map containing CAD drawing, aerial photo, compactor data, and QA sampling coordinates

Data Model

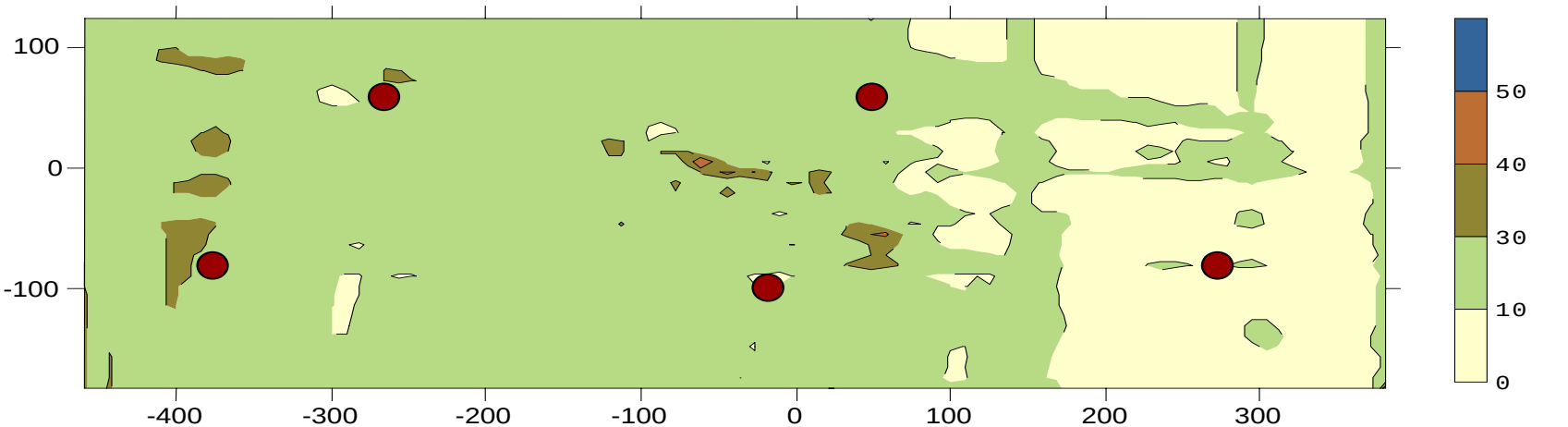

d340452wt_cpA.dgn
d340452top_cpA.dgn
d340452coline_cpA.d
ATWTRBR_pln.dgn
340452InteICompact.
Import from CAD
d340452coline_cpA_I
Create Feature Class
ICQA_DESIGN
BOMAG_Willmar_UTM_selection_test
Kriging (2)
Kriging_BOMA1
Output variance
Create Normal Raster
Output raster
Create Random Raster
Output raster (2)
XYWillmar_deflect


Edit View Insert Selection Tools Window Help
1:1,878
Layer: pointst_boma1
Drawing
Arial
Spatial Analyst
Layer: pointst_boma1
Geostatistical Analyst
Geostatistical Wizard: Step 2 of 4 - Semivariogram/Covariance Modeling
View
Semivariogram
Covariance
γ ·10^-1
60.7
48.56
36.42
24.28
12.14
0
0.89
1.78
2.67
3.56
4.45
5.34
6.23
7.12
Distance, h ·10^-2
Semivariogram/Covariance Surface
Show Search Direction
Angle Direction: 91.6
Angle Tolerance: 45.0
Bandwidth (lags): 1.7
Semivariogram/Covariances:
Var1 & Var1
Models
Model 1
Model 2
Model 3
Circular
Spherical
Tetraspherical
Pentaspherical
Exponential
Gaussian
Rational Quadratic
Hole Effect
K-Bessel
J-Bessel
Stable
Major Range
106.07
Anisotropy
Minor Range
Direction
Parameter
Partial Sill
186.02
Nugget
None
Error Modeling
Shifts
X:
Y:
Lag Size: 59.057
Number of Lags: 12
186.02*Spherical(106.07)
< Back
Next >
Finish
Cancel
Layers
BOMAG_Willmar_UTM_test
BOMAG_Willmar_UTM_train
Bomag_wilmar_UTM_select
XYWillmar_deflect
pointst_boma1
dddfeat2
BOMAG_Willmar_UTM
Wilmar
Value
8 - 20
20 - 30
30 - 50
50 - 60
60 - 129
roads
fsa.sid
county
Mosaic
Mosaic To New Ra
Resample
Relationship Classes
Source
Selection
Favorites
Index
Search
Geostatistical Analyst Wizard
353963.53 5000118.51 Meters

Data Model

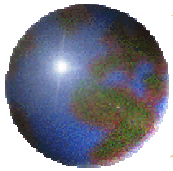


QA TESTING LOCATIONS



STIFFNESS

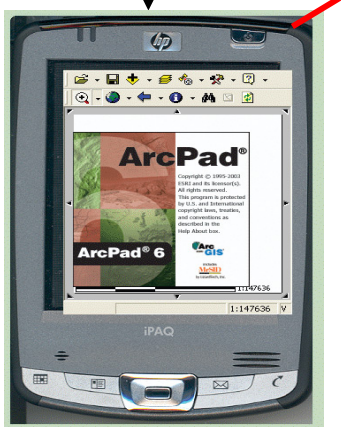
CONTOURED GRID



Evaluating Devices for Field Implementation

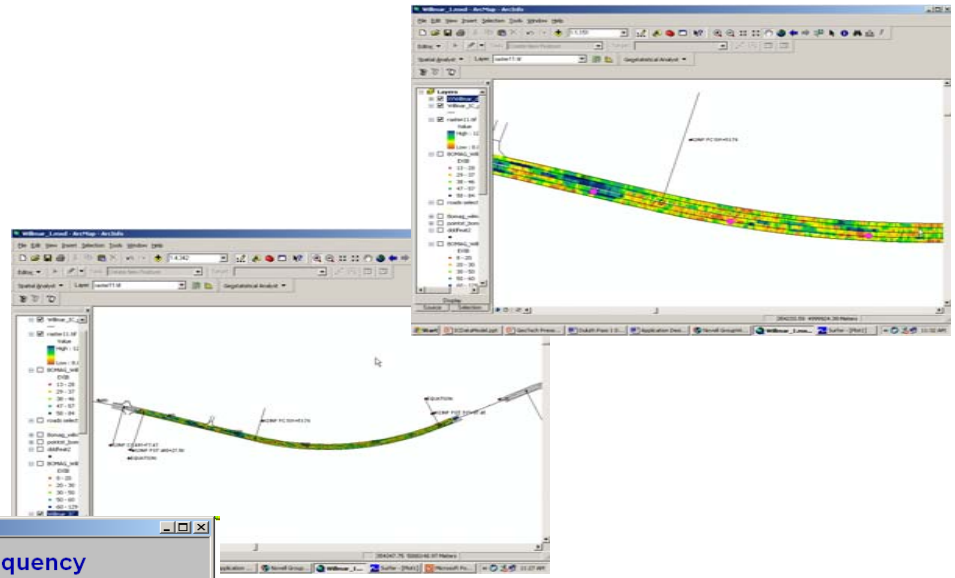
Palm Device for Field Use

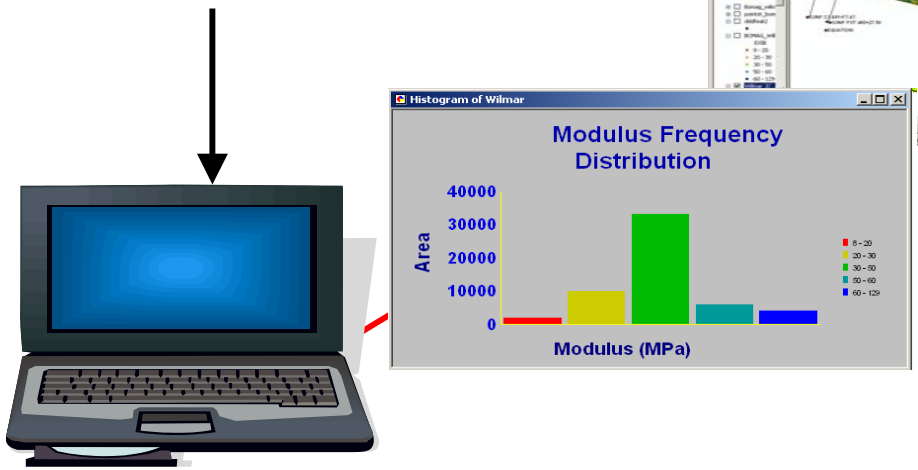
PositionX	PositionY	PositionZ	EVIB
57944.01	143812.1	380.062	36
57944.11	143812.1	380.062	36
57943.91	143812.2	380.073	58
57944.01	143812.2	380.073	58
57944.11	143812.2	380.062	36
57944.21	143812.2	380.062	36
57944.31	143812.2	380.062	36
57943.91	143812.3	380.08	58
57944.01	143812.3	380.073	58
57944.11	143812.3	380.073	58
57944.21	143812.3	380.073	58
57944.31	143812.3	380.062	36
57944.41	143812.3	380.062	36
57944.51	143812.3	380.062	36
57943.81	143812.4	380.08	58
57943.91	143812.4	380.08	58
57944.01	143812.4	380.08	58



Laptop for Field Use

PositionX	PositionY	PositionZ	EVIB
57944.01	143812.1	380.062	36
57944.11	143812.1	380.062	36
57943.91	143812.2	380.073	58
57944.01	143812.2	380.073	58
57944.11	143812.2	380.062	36
57944.21	143812.2	380.062	36
57944.31	143812.2	380.062	36
57943.91	143812.3	380.08	58
57944.01	143812.3	380.073	58
57944.11	143812.3	380.073	58
57944.21	143812.3	380.073	58
57944.31	143812.3	380.062	36
57944.41	143812.3	380.062	36
57944.51	143812.3	380.062	36
57943.81	143812.4	380.08	58
57943.91	143812.4	380.08	58
57944.01	143812.4	380.08	58





Conclusions: Data Format

- Need standardized data format
  - Roller Parameters
    - Frequency, Amplitude, Acceleration of Drum
  - Position data that includes x,y, and z-coordinates for both sides of the drum in UTM NAD 1983 zone 15N
  - Time stamp for each data point accurate to frequency of the drum

Conclusions: Data Processing

- Simplified QA Method
  - Fast and Easy
  - Data intensive
  - Engineering Judgment
- Geostatistically-based Method
  - Relatively fast and easy
  - Preprocessing
  - Scientifically rigorous
  - Objective

Conclusions: Field Devices

- HP Palm: slow processor, ArcPad cannot preprocess data, has wireless and GPS capabilities.
  - Neither Simplified or Geostatistics Method
  - Displays already processed data / data collection

- Laptop (TOUGHBOOK) can Map and process data, ArcView, wireless capabilities.
  - Both Simplified or Geostatistics Method
  - Displays already processed data / data collection

IC Resources

- http://www.dot.state.mn.us/const/tools/innovativecontract.html
- http://mnroad.dot.state.mn.us/research/ictgi/ictgi_welcome.asp

- Mn/DOT Participation with Other DOTs
  - FHWA-led Intelligent Compaction Pooled Fund
  - NCHRP 21-09 Intelligent Compaction Specifications

•Open House/Demonstration at MnROAD

ICTGI Team 2005
Abstracts/Papers/Reports:

- Ruth Roberson
- Bruce Chadbourn
- John Siekmeier

- Cassie O'Neal
- Felipe Camargo
- Peter Davich
- Agueda Guerra
- Brett Larsen

1. **Validation of DCP and LWD Moisture Specification for Granular Materials,** LRRB INV829, September, 2005**.** *Peter Davich, Brett Larsen, Felipe Camargo, John Siekmeier, Ruth Roberson*

2. **Shear Strength of Soils as Influenced by Matric Potential**, 2005 ASA-CSSA-SSSA International Annual Meetings Salt Lake City, UT - November, 2005. *Andry Ranaivoson, John Siekmeier, Ruth Roberson, Satish Gupta*

3. **Intelligent Compaction – A Case History**, 54th Annual GeoTechincal Engineering Conference, February,2006 . *Felipe Camargo, Brett Larsen, Peter Davich, Ruth Roberson, John Siekmeier*

4. **Moisture Retention Characteristics of Aggregate And Granular Materials**, Unsaturated Soils Conference 2006, Phoenix, AZ –April 2006 *Amanjot Singh, Ruth Roberson, Andry Ranaivoson, John Siekmeier, and Satish Gupta*

4D Data: Embankment

GPS timestamp	GPS	Latitude	Longitud	Y (ft.)	X (ft.)	Z(ft)	elevation	spee	heading.	heading	pass	fpsi	rpsi	epsi	pitch	roll	GCMV	GRMV	Gfreq	Gam	Geo V	Efflow	Erflow	EfPp	ErPp	EGPp	ESlopePp	EIPp	ENetP
9/28/2005 7:09	4.0	46.8	92.1	0.0	0.0	0.0	1264.2	1.2	278.9	284.9	1.0	5052.3	4709.4	0.0	4.5	0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.0	17449.0	16725.0	34174.0	3383.9	-1141.9	31.9
9/28/2005 7:09	4.0	46.8	92.1	0.0	-1.0	0.0	1264.3	2.0	279.2	283.7	1.0	4318.4	4054.1	0.0	5.9	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.0	24715.2	23859.2	48574.4	7428.7	2490.8	38.7
9/28/2005 7:09	4.0	46.8	92.1	0.0	-1.0	0.0	1264.3	2.4	296.3	286.7	1.0	3476.3	3234.9	0.0	7.0	-0.2	0.1	0.1	0.1	0.4	0.0	0.0	0.0	23554.6	22539.5	46094.1	10413.8	4175.5	31.5
9/28/2005 7:09	4.0	46.8	92.1	0.0	-1.0	0.0	1264.2	2.4	290.2	287.5	1.0	2704.1	2530.1	0.0	7.7	-0.2	0.1	0.1	0.1	0.4	0.0	0.0	0.0	18322.5	17628.2	35950.6	11453.0	4175.5	20.3
9/28/2005 7:09	4.0	46.8	92.1	0.0	-2.0	0.0	1264.2	2.5	287.0	287.4	1.0	2150.9	2039.0	0.0	8.3	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	15281.7	14896.1	30177.8	12853.0	4702.0	12.6
9/28/2005 7:09	4.0	46.8	92.1	1.0	-2.0	0.1	1264.2	2.6	295.7	289.5	1.0	1996.0	1966.1	0.0	7.9	-0.6	0.1	0.1	0.1	0.4	0.0	0.0	0.1	14706.4	14896.2	29602.6	12717.1	5123.2	11.8
9/28/2005 7:09	4.0	46.8	92.1	1.0	-2.0	0.1	1264.2	2.8	293.3	290.6	1.0	1995.4	1966.4	0.0	7.3	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	16211.7	16428.1	32639.8	12993.3	6334.1	13.3
9/28/2005 7:09	4.0	46.8	92.1	1.0	-3.0	0.0	1264.2	2.5	286.8	289.6	1.0	1886.7	1873.3	0.0	6.7	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13652.4	13939.4	27591.9	10517.5	4912.6	12.2
9/28/2005 7:09	4.0	46.8	92.1	1.0	-3.0	0.0	1264.2	3.0	295.1	291.3	1.0	1761.6	1761.6	0.0	6.0	-0.4	0.1	0.1	0.1	0.4	0.0	0.0	0.1	14891.7	15313.0	30204.7	11051.8	6860.6	12.3
9/28/2005 7:09	4.0	46.8	92.1	1.0	-3.0	0.0	1264.2	2.8	287.6	290.3	1.0	1663.0	1647.4	0.0	5.4	-0.2	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13237.5	13483.8	26721.2	9314.9	6070.9	11.3
9/28/2005 7:09	4.0	46.8	92.1	1.0	-4.0	0.0	1264.2	2.8	280.8	287.6	1.0	1607.6	1621.5	0.0	4.7	0.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12955.1	13437.0	26392.1	8361.9	6228.8	11.8
9/28/2005 7:09	4.0	46.8	92.1	1.0	-4.0	0.0	1264.2	2.9	289.6	288.2	1.0	1536.5	1546.1	0.0	4.3	0.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12887.8	13335.0	26222.7	7811.3	6755.3	11.7
9/28/2005 7:09	4.0	46.8	92.1	2.0	-5.0	0.1	1264.2	3.0	286.1	287.6	1.0	1468.4	1448.4	0.0	3.9	0.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12509.2	12687.8	25197.0	7343.8	6965.9	10.9
9/28/2005 7:09	4.0	46.8	92.1	2.0	-5.0	0.0	1264.2	2.7	284.5	286.7	1.0	1473.0	1507.2	0.0	3.3	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11531.3	12133.1	23664.3	5599.6	5860.3	12.2
9/28/2005 7:09	4.0	46.8	92.1	2.0	-5.0	0.0	1264.2	2.8	285.7	286.4	1.0	1628.8	1645.9	0.0	2.7	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	12911.4	13416.2	26327.7	4708.6	6018.2	15.6
9/28/2005 7:09	4.0	46.8	92.1	2.0	-6.0	0.0	1264.2	2.7	283.4	285.6	1.0	1758.7	1800.5	0.0	2.4	-0.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13652.3	14372.0	28024.4	4009.2	5755.0	18.3
9/28/2005 7:09	4.0	46.8	92.1	2.0	-6.0	0.0	1264.3	2.9	280.3	284.1	1.0	1792.7	1784.8	0.0	2.0	-1.2	0.1	0.1	0.1	0.4	0.0	0.0	0.1	14741.3	15092.2	29833.5	3586.5	6492.0	19.8
9/28/2005 7:09	4.0	46.8	92.1	2.0	-7.0	0.0	1264.3	2.7	285.1	284.4	1.0	1766.6	1777.3	0.0	1.7	-1.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13771.2	14246.9	28018.1	2913.5	5807.6	19.3
9/28/2005 7:09	4.0	46.8	92.1	2.0	-7.0	0.0	1264.3	3.2	290.1	286.2	1.0	1699.9	1698.7	0.0	1.8	-1.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	15319.9	15742.6	31062.5	3504.8	7755.6	19.8
9/28/2005 7:09	4.0	46.8	92.1	2.0	-7.0	0.0	1264.3	2.9	286.9	286.4	1.0	1599.8	1615.2	0.0	1.9	-2.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	13155.1	13657.3	26812.3	3374.9	6492.0	16.9
9/28/2005 7:09	4.0	46.8	92.1	2.0	-8.0	0.0	1264.2	2.9	286.9	286.4	1.0	1435.3	1464.6	0.0	2.0	-2.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11802.6	12384.3	24186.8	3539.7	6492.0	14.2
9/28/2005 7:09	4.0	46.8	92.1	3.0	-8.0	0.0	1264.2	3.3	295.8	289.5	1.0	1159.7	1133.0	0.0	2.1	-2.5	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10986.1	11037.0	22023.0	4321.5	8492.7	9.2
9/28/2005 7:09	4.0	46.8	92.1	3.0	-9.0	0.0	1264.2	2.8	289.5	289.5	1.0	979.0	1021.7	0.0	1.9	-1.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	7825.1	8396.9	16222.0	3328.0	6123.5	6.8
9/28/2005 7:09	4.0	46.8	92.1	3.0	-9.0	0.0	1264.3	2.9	279.8	286.7	1.0	1076.2	1089.5	0.0	1.6	-1.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	8814.2	9175.9	17990.1	2934.9	6439.4	8.6
9/28/2005 7:09	4.0	46.8	92.1	3.0	-10.0	0.0	1264.3	2.9	284.7	286.1	1.0	1252.0	1274.0	0.0	1.3	-1.6	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10459.8	10945.1	21404.9	2366.3	6702.6	12.3
9/28/2005 7:09	4.0	46.8	92.1	3.0	-10.0	0.0	1264.3	2.8	288.6	286.8	1.0	1375.3	1389.8	0.0	0.9	-1.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11037.4	11469.4	22506.8	1666.7	6176.2	14.7
9/28/2005 7:09	4.0	46.8	92.1	3.0	-10.0	0.0	1264.2	2.8	284.9	286.3	1.0	1447.2	1481.7	0.0	0.7	-2.2	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11424.4	12027.8	23452.2	1163.1	5965.6	16.3
9/28/2005 7:09	4.0	46.8	92.1	3.0	-11.0	##	1264.3	2.8	284.1	285.7	1.0	1424.9	1431.0	0.0	0.6	-2.7	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11482.4	11857.7	23340.1	1093.5	6228.8	16.0
9/28/2005 7:09	4.0	46.8	92.1	3.0	-11.0	##	1264.3	2.9	290.9	287.2	1.0	1377.0	1381.6	0.0	0.7	-2.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11413.7	11776.2	23189.9	1253.9	6597.3	15.3
9/28/2005 7:09	4.0	46.8	92.1	4.0	-12.0	0.0	1264.3	2.9	289.6	287.9	1.0	1369.2	1377.9	0.0	0.8	-2.8	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11393.8	11790.7	23184.5	1454.2	6650.0	15.1
9/28/2005 7:09	4.0	46.8	92.1	4.0	-12.0	##	1264.3	2.8	285.3	287.2	1.0	1310.9	1339.9	0.0	0.9	-2.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10649.9	11193.6	21843.5	1616.0	6334.1	13.9
9/28/2005 7:09	4.0	46.8	92.1	4.0	-12.0	##	1264.3	2.9	287.8	287.3	1.0	1252.0	1269.1	0.0	0.9	-3.0	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10542.1	10988.6	21530.7	1745.0	6807.9	13.0
9/28/2005 7:09	4.0	46.8	92.1	4.0	-13.0	##	1264.3	2.8	292.3	288.8	1.0	1171.0	1198.3	0.0	1.0	-3.0	0.1	0.1	0.1	0.4	0.0	0.0	0.1	9514.0	10011.0	19525.0	1717.8	6334.1	11.5
9/28/2005 7:09	4.0	46.8	92.1	4.0	-13.0	0.0	1264.3	3.1	293.4	290.2	1.0	1143.8	1151.9	0.0	0.9	-3.0	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10120.1	10480.4	20600.5	1828.1	7492.4	11.3
9/28/2005 7:09	4.0	46.8	92.1	4.0	-14.0	##	1264.3	2.8	289.9	290.1	1.0	1153.9	1183.8	0.0	0.9	-3.1	0.1	0.1	0.1	0.4	0.0	0.0	0.1	9185.2	9689.6	18874.8	1595.9	6070.9	11.2
9/28/2005 7:09	4.0	46.8	92.1	4.0	-14.0	##	1264.3	3.1	285.1	288.5	1.0	1238.3	1250.2	0.0	0.9	-2.9	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11079.0	11501.9	22581.0	1849.3	7650.3	13.1
9/28/2005 7:09	4.0	46.8	92.1	5.0	-14.0	##	1264.3	3.0	287.2	288.1	1.0	1269.1	1321.6	0.0	0.9	-2.5	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10811.5	11577.3	22388.8	1758.7	6965.9	13.7
9/28/2005 7:09	4.0	46.8	92.1	5.0	-15.0	##	1264.3	3.1	286.1	287.5	1.0	1264.5	1270.0	0.0	1.0	-2.5	0.1	0.1	0.1	0.4	0.0	0.0	0.1	11354.2	11726.4	23080.6	1960.7	7702.9	13.4
9/28/2005 7:09	4.0	46.8	92.1	5.0	-15.0	##	1264.3	2.9	285.9	287.0	1.0	1209.9	1235.2	0.0	0.9	-2.3	0.1	0.1	0.1	0.4	0.0	0.0	0.1	10188.0	10694.7	20882.7	1688.9	6807.9	12.4