Development of a Road Deficiency GIS Using Data from Automated Multi-Sensor Systems

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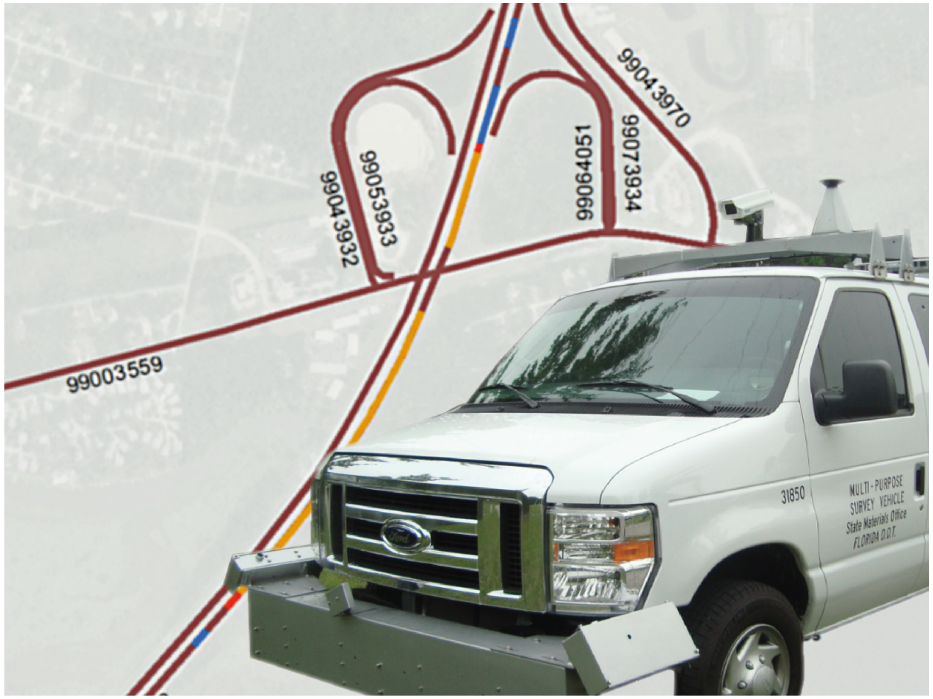

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Presentation Outline

- Introduction
- Objective
- Automated Data Collection Systems
- Development and Implementation of ARDIS
- Results
- Conclusion
- Discussion

Introduction

- Poor pavement surface drainage
  - Hydroplaning
  - Increase heavy vehicle stopping and passing distance

Introduction

- Agencies
  - Minimal control over:
    - driver
    - vehicle condition
    - environment

  - More control:
    - identifying casual or contributing factors to roadway departure

Introduction

- Traditional Pavement Evaluation Methods
  - Cross-slope
  - Longitudinal grade
  - Rut depth
  - Pavement friction

Introduction

- Data Analysis
  - Identify areas with deficient roadway geometry or inadequate drainage
  - Locate areas prone to hydroplaning

Introduction

- Traditional Pavement Evaluation
  - Relatively Slow
  - Tedious
  - Needs Maintenance of Traffic
  - Unsafe
  - Expensive
  - Subjective
  - Prone to Human Errors

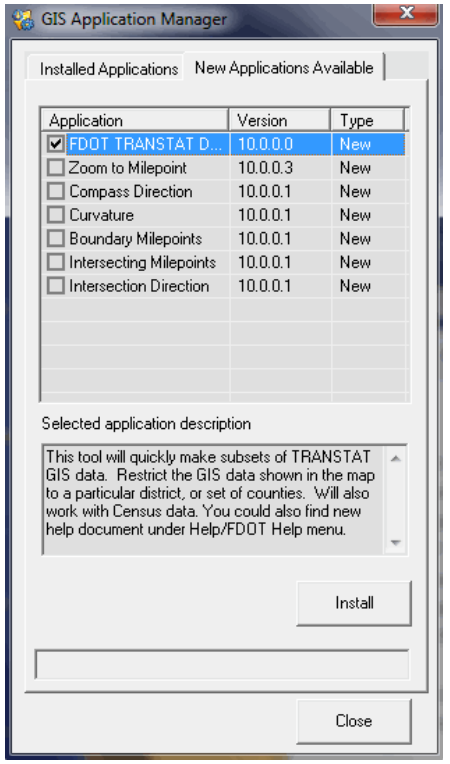
Introduction

- Current/Future Trends
  - Automation
  - Use of Automated Data Collection Systems
  - Equipped with sensors
  - Efficient and cost-effective
  - Improvements in agency's processes
  - Allocation of funds driven by rating
  - QA/QC

Introduction

- FDOT
  - GIS Custom Tools (Curvature, Zoom to milepost, etc.)
  - Map layers
  - Geodatabases
  - Services

- No tool or GIS map layer to assess and map areas prone to hydroplaning



Objective

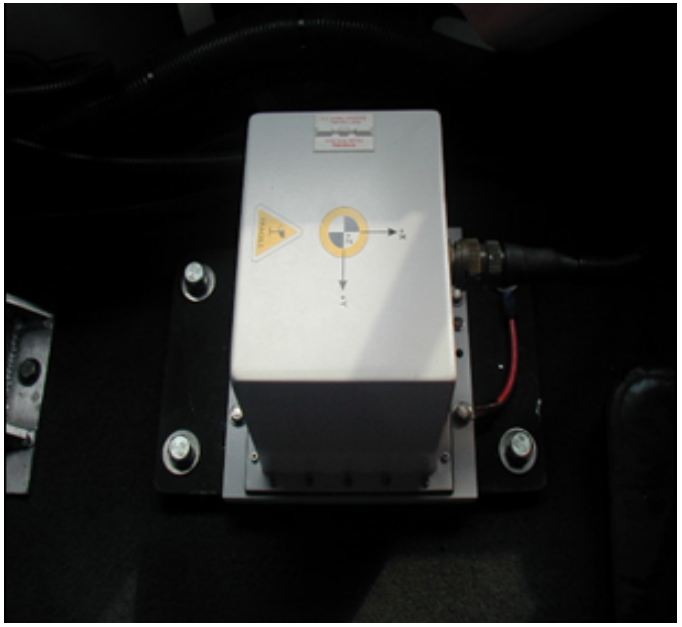
- Development of GIS application for mapping areas prone to hydroplaning
- Application design providing seamless integration with FDOT pavement evaluation database
- Test functionality on a pilot project

Automated Data Collection System

- Automated Data Collection System (MPSV)
  - Multi-sensor system:
    - Laser profiler
    - POS
    - DMI
    - ROW Camera
    - Pavement Camera

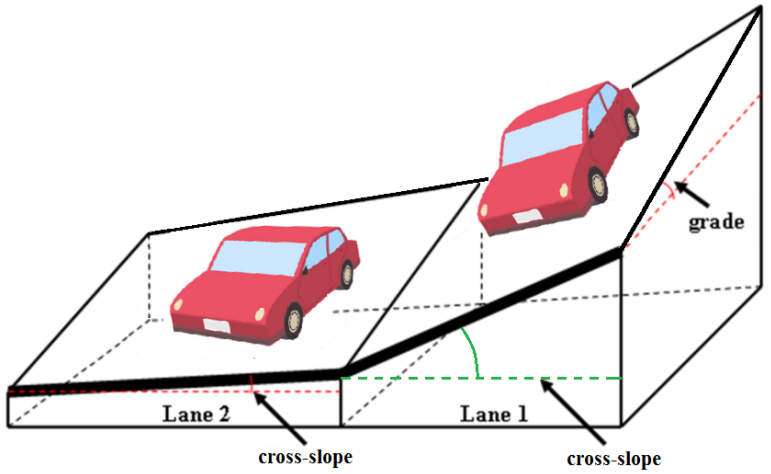
Automated Data Collection System

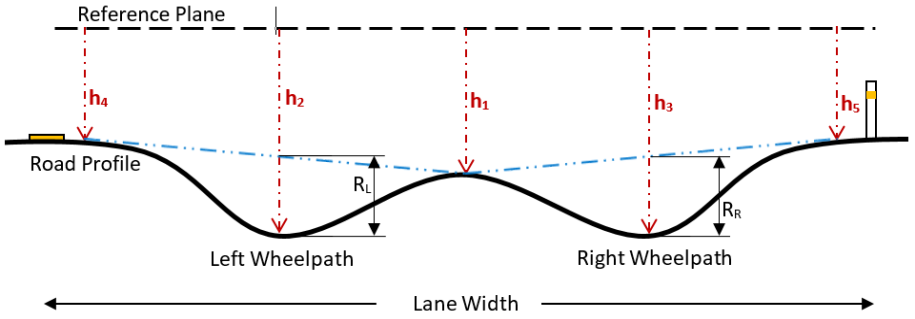
- MPSV – Components



Automated Data Collection System

- Roadway Characteristics Measured with MPSV
  - **Cross-slope**
  - **Longitudinal grade**
  - **Rutting**
  - Location
  - Ride
  - Radius of Curvature



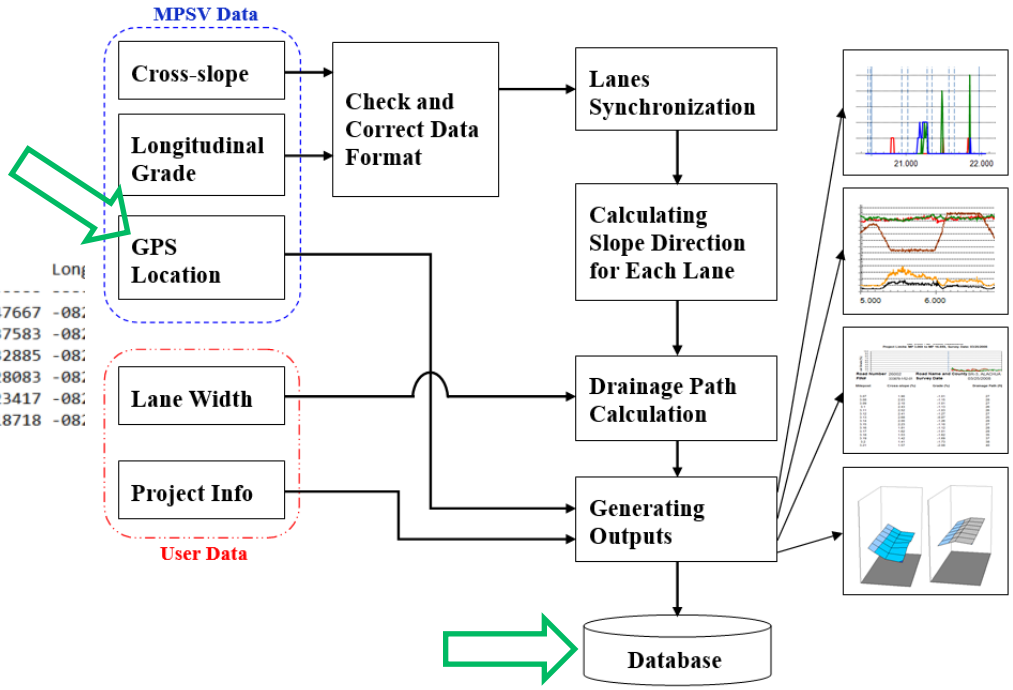


Implementation – Data Processing

- Pre-processing MPSV Collected Data

```
COUNTY:                          DATE COLLECTED:    08/31/2015
ROUTE:            SR2            TIME COLLECTED:    15:11:55
DIRECTION:        East(+)        OPERATOR:          CH
LANE:             R1             DRIVER:            CH
VEHICLE:          31850          DCF:               3960.15
UNITS:            ENGLISH        WAVELENGTH-LONG:   none
SECTION:                         RPT VERSION:       2.3.6.20
SUB SEC:                         MDR VERSION:       WP3.7.6.0
RUNOPTION5:                      SENSOR CAL DATE:   08/31/2015
SAMPLE DISTANCE:  0.73 in (1)    ACCEL CAL DATE:    08/31/2015
PROFILE DISTANCE: N.A.           AVG SPEED:         0.0mph
OUTPUTFILENAME:   F:\~CS G DP Rut Evaluation\8-31-2015\
```

Miles Ref Post	Deg Slope	Deg Grade	Feet Radius Curv	Deg Rad Curv Dir	Latitude	Long
10.4835	0.662	-0.721			+29.679347667	-08
10.4845	1.056	-0.411			+29.679337583	-08
10.4851	1.083	-0.386			+29.679332885	-08
10.4858	1.140	-0.378			+29.679328083	-08
10.4864	1.106	-0.438			+29.679323417	-08
10.4871	1.244	-0.502			+29.679318718	-08

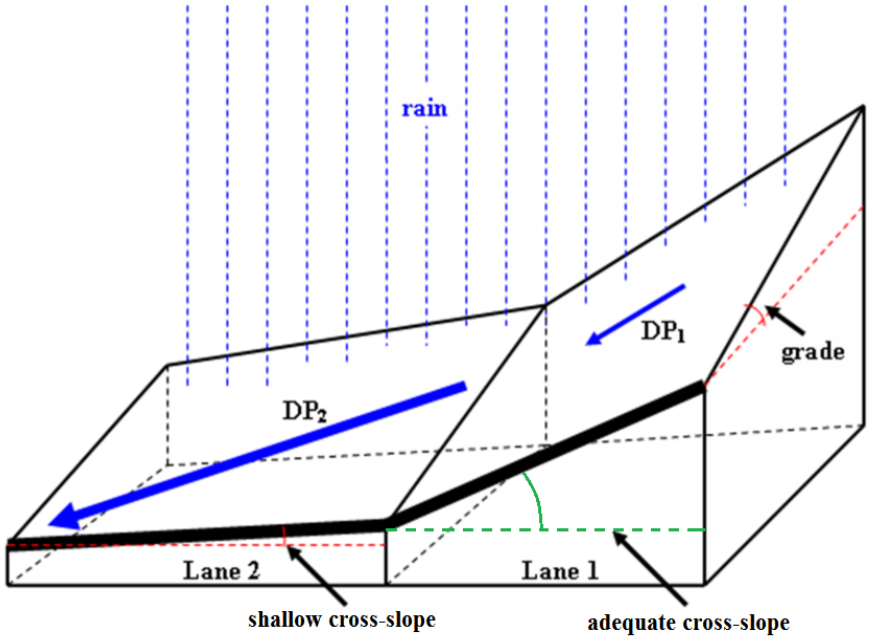


Applied Methodology – Roadway Geometry

- Drainage Path
  - Relates cross-slope, longitudinal grade, and pavement drainage width

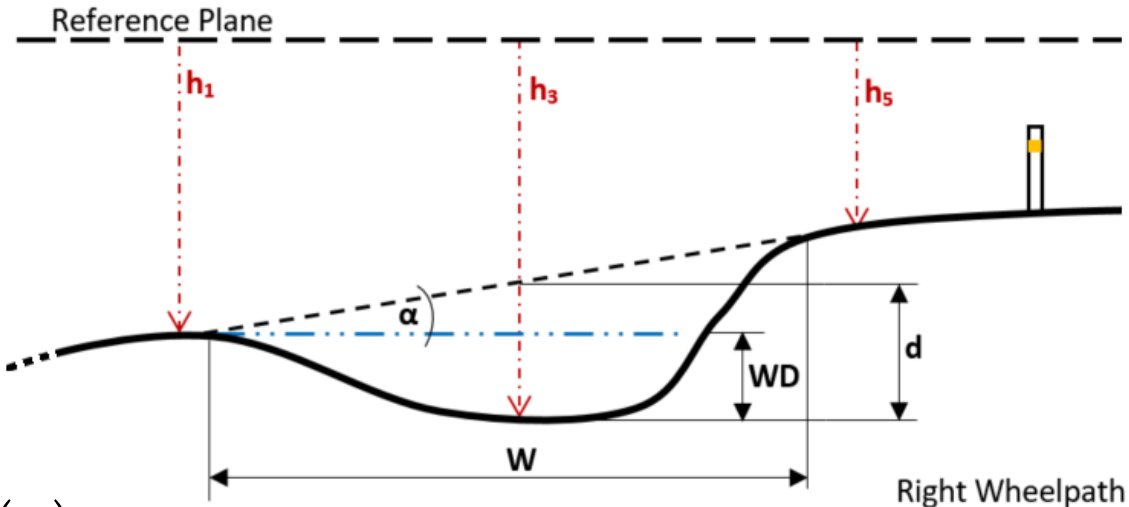
$$DP = W\sqrt{\left[1+\left(\frac{LG}{CS}\right)^2\right]}$$

  - Relative distance water runoff travels before leaving the pavement



Applied Methodology – Pavement Rut

- Maximum Water Depth



$$WD = d - 1/2W\tan(\alpha)$$

Development of Automated Roadway Deficiency Information System

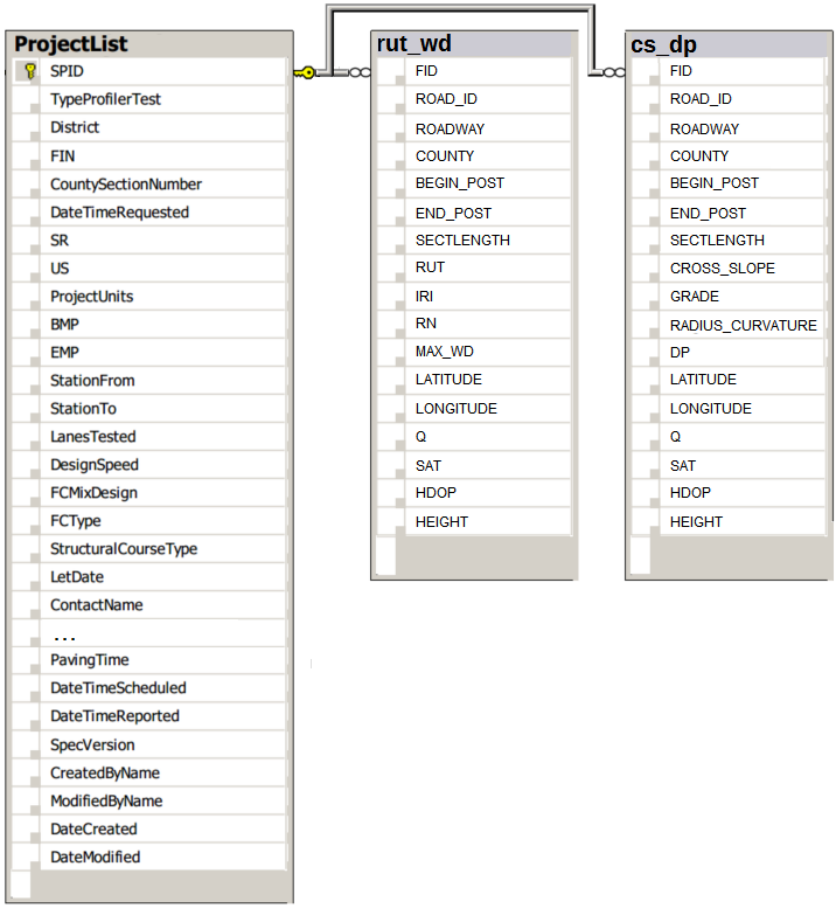
- Methodology
  - Roadway data – spatial nature
  - GIS Use for:
    - Modeling processes in pavement evaluation
    - Detection of areas prone to hydroplaning
    - Pre-processing data
    - Spatial analysis
    - Display trends and patterns
    - Create maps and reports

Development of Automated Roadway Deficiency Information System

- Data Sources
  - Data Collected with MPSV and processed with ACAP
    - Linear referencing
    - Roadway geometry
    - Drainage path length
    - Maximum water depth
    - Geographical coordinates
  - FDOT GIS Basemap Route
    - Roadway Characteristics Inventory database
    - Basemap dataset (linear features)

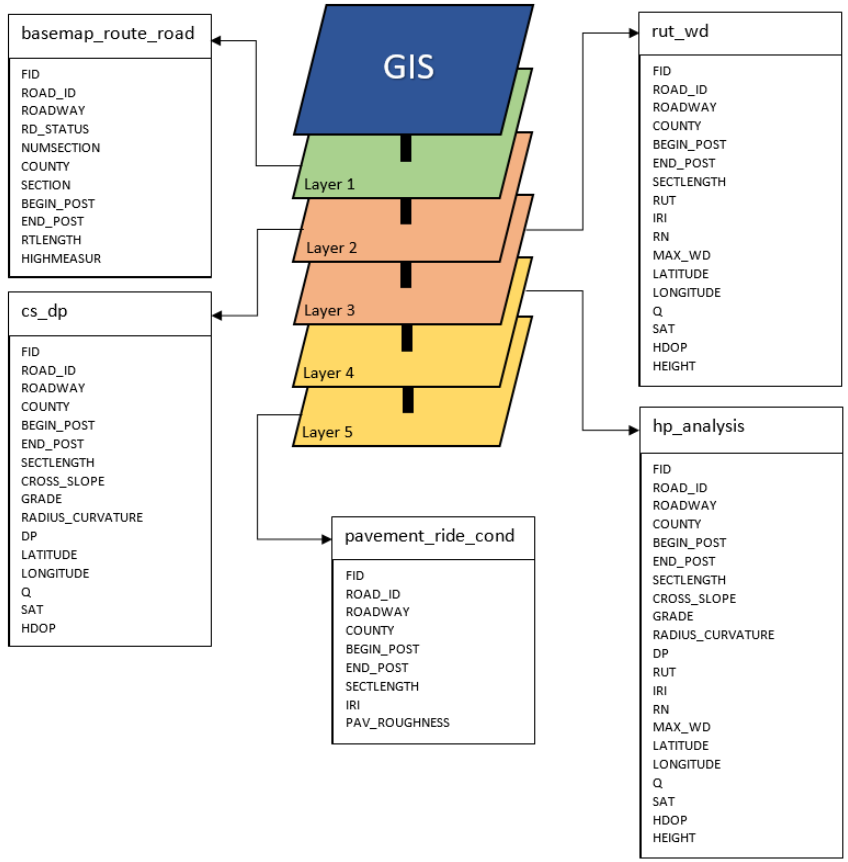
Development of Automated Roadway Deficiency Information System

- Database Design



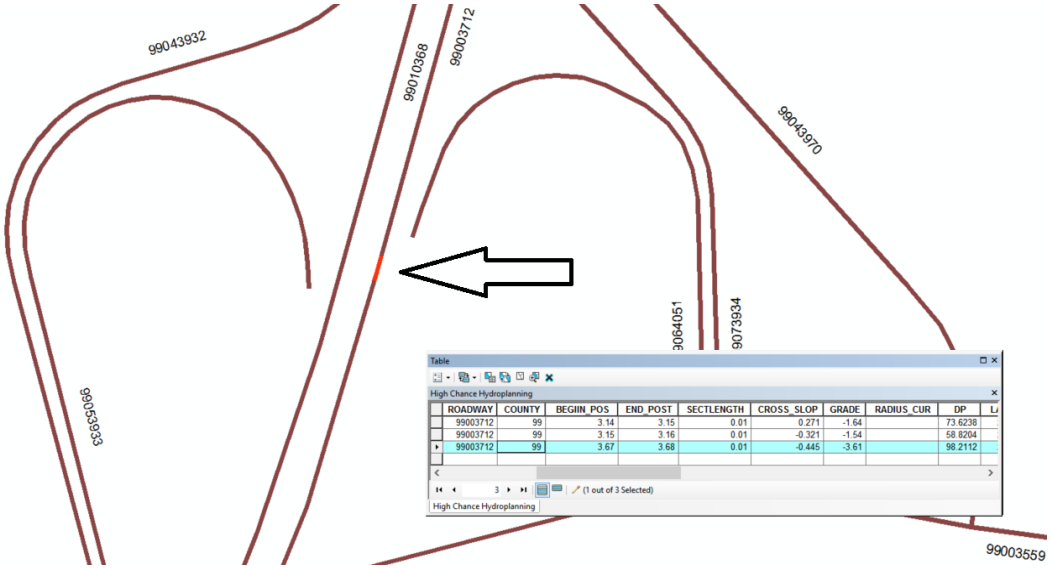
Implementation of Automated Roadway Deficiency Information System

- GIS Implementation
  - ArcGIS
  - cs_dp_SELECT (DP > 55 ft (16.7 m)
  - rut_wd_SELECT (WD > 0.1 inch (2.5 mm))
  - hp_analysis result of intersection of cs_dp_SELECT and rut_wd_SELECT



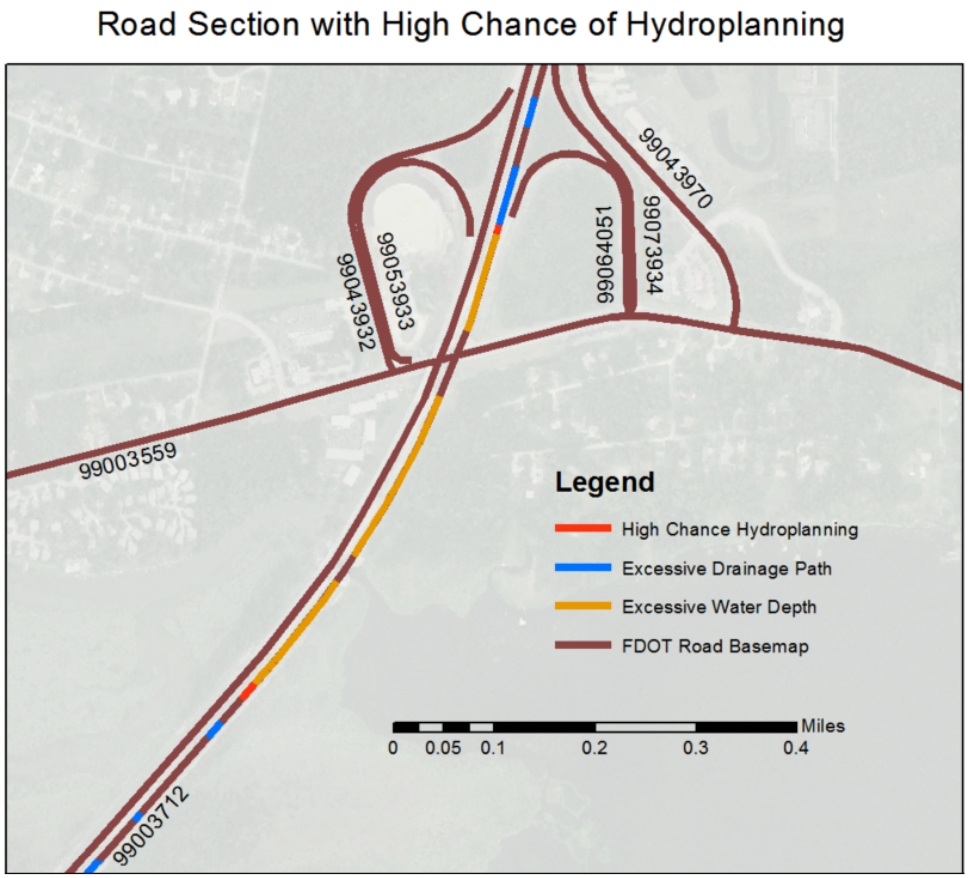
Results

- ARDIS
  - General view of entire road network
  - Specific information about roadway geometry or rut deficiencies
  - Typical query:



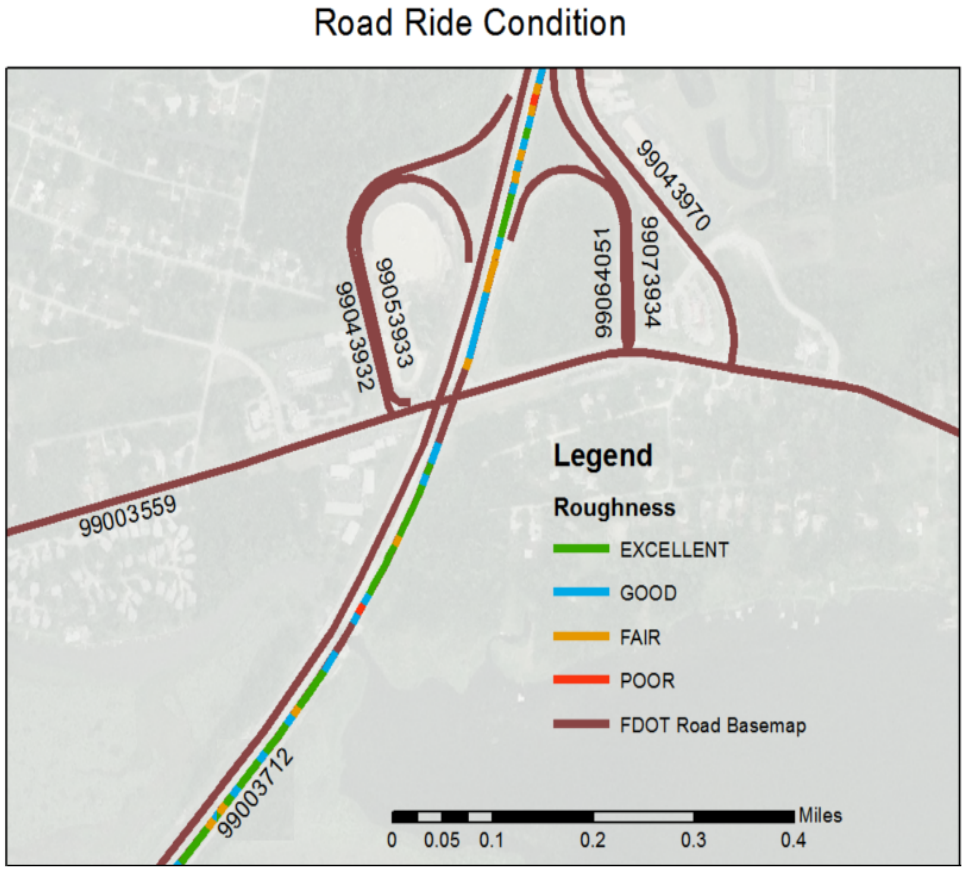
Results

- ARDIS
  - Display problem-prone areas:



Results

- ARDIS
  - Display roadway ride condition:



Conclusion

- Advantage of ARDIS :
  - Tool for identifying deficient areas
  - Helps engineers to formulate short-term and long-term mitigating solutions
  - Enhancement to existing programs
  - Provides overall view of network for fund allocation
- Use of automated data collection system:
  - Improves safety
  - Cost efficient
  - Reduces traffic delays

Discussion

- ARDIS under development
- Tested on small number of projects
- Plan to import all collected projects

- Improvement:
  - Drainage path length at transition areas not as deficient
  - Maximum water depth calculate from deepest rut

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