Inclement Weather Signal Timings

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LIST OF ACRONYMS

CDOT	Colorado Department of Transportation
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
IEEE	Institute of Electrical and Electronic Engineers
ITE	Institute of Transportation Engineers
MNDOT	Minnesota Department of Transportation
MOE	Measure of Effectiveness
NCHRP	National Council of Highway Research Practice
ODOT	Ohio Department of Transportation
SCOOT	Split, Cycle, and Optimization Technique
TRB	Transportation Research Board
UDOT	Utah Department Of Transportation
UTC	Urban Traffic Control

EXECUTIVE SUMMARY

This study examines signal timing in inclement weather conditions. With the completion of the Utah Department of Transportation's (UDOT) Advanced Traffic Management System (ATMS), UDOT will have the capability to change signal timing plans from a central location by communicating with each controller through fiber optic technology. With this ability, it has become feasible to have a library of special signal timing plans. One of these plans could be for inclement weather conditions. This research reviews relevant literature for similar studies, interviewing other state departments of transportation, and collecting local traffic flow data to determine traffic flow characteristics during inclement weather.

Traffic flow data is collected over a range of seven inclement weather severity conditions at two intersections: 700 East / 900 South and 1300 East / 500 South. The results of the data collection indicate that the largest decrease in vehicle performance occurs when slush begins to accumulate on the road surface. After this critical point, saturation flows decrease by 20 percent and speeds decrease by 30 percent. Start-up lost times also increase by 23 percent. These results are compatible with those found in similar research. Few other state departments of transportation have considered modifying their signal timings in inclement weather. While Minnesota and Alaska both have done research in the area, Alaska is the only known state that currently has a signal timing plan for inclement weather conditions.

Based on the collected data and the relevant research, it is recommended that UDOT develop and implement modified coordinated signal timing plans for the major signalized corridors in the Salt Lake Valley. The plans can easily be developed by modifying the data used to create standard "dry" signal timing plans and by changing a small number of other parameters.

It is further recommended that signal timing plans be manually "switched on" by a trained operator or engineer once an alarm identifies the potential need. The trigger for the alarm may include observed reductions in travel speeds by mid-block detectors or reduced saturation flows from stop bar detectors. Four general criteria must be considered to ensure that such a plan gives the maximum benefit. First, the storm must be sufficiently severe to cause "inclement" road surface conditions. Second, the

storm duration must be predicted to continue to cause inclement surface conditions for at least 20 minutes, to allow for the negative effects of transitioning from one signal timing plan to another to be minimized. Third, the storm must affect a sufficient length of corridor to benefit the majority. Thus, many microclimate events that only affect a small geographical area should not initiate the new timing plans. Finally, the traffic volumes must be substantial enough to warrant the time to switch a plan. A.m. and p.m. peak hours will be the most likely candidates, while off-peak plans on specific corridors should be individually considered. Special attention should be given to individual intersections that have high speed or steeply graded approaches, as they will cause additional problems in low traction conditions.

Chapter 1. Introduction

Drivers are more cautious during heavy rain and snow. These adverse road conditions cause vehicles to travel and accelerate more slowly. Normal signal coordination plans become unsuitable during adverse weather. This is because the traffic flow parameters used to develop the dry weather plans change. Ideally, a traffic signal coordination system would adapt to changing traffic flows and travel conditions as they occur. A compromise between the ideal control system and one that does nothing to accommodate signal coordination in adverse weather is to develop an inclement weather plan.

In the past, the implementation of such a specialized plan was impractical because it required an operator to visit each traffic signal and manually change the signal timing plan at the signal controller. The new Utah Department of Transportation (UDOT) Advanced Traffic Management System (ATMS) soon will have real-time communication with many of the traffic signal controllers throughout the Salt Lake Valley. This communication link makes the possibility of using a specialized signal coordination plan simple.

An inclement weather signal coordination plan must be created using the traffic flow parameters specific to inclement weather. This research seeks to quantify these traffic flow parameters. The modified parameters can then be compared to dry condition data to determine the percent change. Generalized results can then be used to modify dry condition data collected for other arterials. Thus, inclement weather plans can easily be created for other arterial streets in the area. The modified signal timing plans are expected to generally have different offset values than the dry weather plans.

To identify the change in traffic flow parameters, data was collected over a range of weather conditions. Specifically, saturation flow, free flow speeds, and start-up lost times were collected at two intersections during dry weather and various intensity levels of rain and snow. This data is then compared to identify the percent change from the dry weather condition. Comparisons of the data collected with other similar research done in Alaska and Minnesota provides validation for the Utah findings.

Chapter 2. Literature Review

Limited research exits that focuses directly on inclement weather signal timing. Such papers address how inclement weather affects: saturation flows, capacities, pedestrian walking speeds, design of freeway interchanges, and others. Presented here is the most relevant research.

Bernardin, Lochmueller and Associates, 1995, assess the changes in speeds and saturation flows during extreme winter weather on a 24-signal network. This study measured several traffic flow parameters in summer, winter, and severe winter conditions. During each of these conditions, they measured saturation flow, vehicle speeds, lost time, and capacity. The study asserts that summer signal timing parameters are inappropriate in winter and extreme conditions because of slower vehicle speeds and unreachable detectors which often are covered by packed snow. The study defines summer as the time when temperatures are above 14º F, on dry roads, or above 32º F on wet roads (without ice). Winter is defined as the time of year when temperatures range from -22º F to 14º F with dry pavement or with well-sanded hard-packed snow on the road. "Extreme" is when the air temperature is below -22º F or during snowfall, blizzard, and/or freezing rain, resulting in slippery roads and reduced visibility. The existing timing plans were assumed to be appropriate for dry/summer conditions. Therefore, winter and extreme conditions were the main areas of focus for modifying traffic flow parameters. The traffic signal optimization packages SIGNAL 85, and TRANSYT-7F were used to develop an optimized signal timing plan. Signal 85 was used to run chosen cycle lengths to generate final phase sequences and splits. TRANSYT-7F was used to generate offsets that yield better arterial progression in the network. The relevant results of the study are provided in Table 2.1

An important conclusion reached in this study was that all-red and amber times should not be changed during winter conditions. It states that although much research has been done in this area, there still is much disagreement on how the parameters should be timed. Anchorage traffic signals generally have 4-5 second yellow intervals and 1-3 second all-red intervals. It said that if the parameters were to change, it would be based on reduced speeds, increasing the all-red time and reducing the amber time.

The study's final recommendation was to calculate these parameters based on current standards to protect the municipality from liability.

Table 2.1 MOE Improvements from the Anchorage Winter Signal Timing Modification

MOE	Existing Timing	Recommended Timing	Anticipated Improvement
Total travel Time	1630 veh-hr/hr	1416 veh-hr/hr	13%
Total Delay	930 veh-hr/hr	716 veh-hr/hr	23%
Average Delay	49.8 sec/veh	38.4 sec/veh	23%
Percentage Stops	64%	68%	-6%
System speed	17.1 mph	19.1 mph	-12%

(Maki 1999) describes a study for the Minnesota Department of Transportation (MnDOT) to evaluate the feasibility of implementing a traffic signal timing plan for inclement weather. The following data was collected from 3-8 p.m. on several weekdays: current signal timing, intersection geometry, turning movement counts, travel time, volume and occupancy (system detectors) start-up delay, and saturation flow rates. They also collected weather-related data from road weather information system (RWIS) devices, including air temperature, pavement temperature, relative humidity, and roadway condition (i.e. icy, plowed), and dew point. All of this was done on Trunk Hwy 36 in Minneapolis, Minn. The study defines inclement weather as a storm with accumulation of three inches of snow or more. Data also was collected on fair-weather days for comparison purposes. A street network, (Hwy 36 in Minneapolis), was simulated in existing normal conditions to establish a basis of comparison. The SYNCHRO III traffic signal optimization software was used to create optimized signal timings for inclement conditions. In the simulation, adverse conditions were created by modifying the saturation flow rates, average speeds, and lost times of the traffic. Comparison data was then gathered from the software output under the signal timings in use and the signal timings optimized for inclement weather. The simulation yielded a six percent overall improvement of MOE's with an optimized signal-timing plan on a 125-second cycle.

Table 2.2 Measures of Effectiveness for Minnesota Study

Scenario	Cycle Length (Sec)	Volume on TH 36 (veh/ hr)	Percentile Signal Delay/Veh (Sec.)	Stops/Veh (Avg)	Average Speed (Mph)
"Normal" Weather	160	2513	55	0.72	16
"Adverse" (Existing)	160	1912	52	0.72	13
"Adverse" (Optimized)	160	1912	48	0.68	13

An interesting ancillary conclusion of the study was that volumes during inclement weather was 15-20 percent lower than volumes collected during the same time period (3-8 p.m.) on a normal day and 15-30 percent during peak hour (5-6 p.m.). The speeds were about 40 percent lower during inclement weather, falling from 44 mph to 26 mph. The start-up delay increased from two to three seconds. The saturation flow rate also dropped by 11 percent from 1,800 vplphg to 1,600 vplphg.

The study also explored the possibility of having the inclement weather plan automatically activated by several RWIS sensors located near the intersections. The study concluded that there is not enough correlation between RWIS data and the actual road conditions to do this reliably.

Parsonson (1992) also discusses the principles of signal timing for adverse weather. This study relates traffic in adverse weather conditions to traffic in a congested state. The study recommends that a snowy corridor be "flushed" by setting all corridors signals to green at the same time. This is a similar management scheme for some heavily congested corridors.

The design and/or operation of a transportation system, according to Jones and Goolsby (1970), may be based on assumptions of "normal environmental conditions." However, to have a comprehensive (system) design or control plan, the operation also must be predictable under degraded environmental conditions. The report is intended to assess the quantitative effects of rain on the design capacity of freeways. They also defend the need for designing transportation systems, which minimize the effects of environmental disturbances such as rain or snow.

FHWA (1977) assesses the economic impacts of adverse weather on all types of highways. Some of these related impacts are: extra fuel consumption, operating costs (mechanical maintenance etc.), fixed costs (insurance, depreciation, taxes, etc.), and work delay. As supportive evidence to their findings, they also measured interstate speeds of vehicles in varying degrees of inclement weather. Their findings are provided in Table 2.3.

Table 2.3 Inclement Weather Speed Reductions (FHWA 1977)

	Condition	Percent Reduction
1	Dry	0%
2	Wet	0%
3	Wet and Snowing	13%
4	Wet and Slushy	22%
5	Slushy in Wheel Paths	30%
6	Snowy and Sticking	35%
7	Snowing and Packed	42%

Botha and Kruse (1992) show how inclement weather reduces saturation flow rates after collecting extensive headway data. The study assesses the effects of residual ice and snow on saturation flow rates and start-up lost times at signalized intersections in Fairbanks, Alaska. The winter data collection and subsequent analysis are reported and compared with the saturation flow rates suggested in the Highway Capacity Manual (HCM). The winter saturation flows measured were much less than those suggested in the HCM. It was found that when snow and ice were prevalent at signalized intersections, saturation flow rates are reduced by about 20 percent. Table 2.4 shows the results of the study.

Table 2.4 Comparison of Saturation Flow Rates in Botha-Kruse Study

Category	Winter	Summer	HCM	Winter/summer reduction	Winter/HCM reduction
Saturation flow (vplphpg)	1,463	1,714	1,800	15%	19%

Knoblauch, Pietrucha, and Nitzburg (1996) study pedestrian crossing characteristics during inclement weather. The study finds that as the severity of the weather increases, the walking speed of the pedestrians also increases.

Gilliam (1992) demonstrates how to measure the increase in congestion of a signal network due to inclement weather. Levels of congestion can easily be found when road conditions are wet and travel times are greater than that under normal weather conditions. Also, when a reduction in saturation flow is found on corridors, it becomes possible to relieve these areas of congestion due to poor weather conditions using a SCOOT system. To accomplish this, specially developed wet weather parameters (such as decreased saturation flow and longer travel times) can be input into SCOOT. It is expected that the SCOOT system will perform more appropriately and optimize traffic flow when wet parameters are applied. The precise monitoring of traffic conditions has allowed more attention to be focused towards the operation of a SCOOT system, and its perceived ability to handle varying traffic conditions over long periods of time and under different weather conditions.

Chapter 3. Current Practice by Other State DOT Agencies

As part of this project, several other state DOT agencies were contacted to find out current practices to accommodate signal timings during inclement weather. In February 2000, a letter was e-mailed to 11 state DOT agencies to see if inclement weather signal timing had been addressed. The states contacted are: (Alaska, Colorado, Idaho, Kansas, Maryland, Michigan, Minnesota, Ohio, Pennsylvania, Vermont, and Virginia). The text of the letter is shown in Figure 3.1.

> Dear Sirs:
>
> In Salt Lake City, the Utah Traffic lab is researching the feasibility of adapting the traffic signal timing at select intersections in our city during heavy rain or snowfall. Each winter here, it snows heavily on many occasions during the peak travel hours (both AM and PM). Our goal is to quantitatively show how inclement weather (heavy snow or rainstorm) affects the saturation flow and speeds of vehicles through an intersection with (at least an inch) of snow on the road. Our goal is to design a more efficient signal timing plan, which can accommodate slower traffic during heavy rain or snowy weather situations. We would like to ask if your state DOT agency or municipalities have ever investigated this particular issue (inclement weather signal timing). Or if are you perhaps considering to do so. Please forward this message to someone who might be aware of such. If so, we would be very interested in learning what your agency has contributed to this topic: please respond to:
>
> utraflab@eng.utah.edu
>
> Thank you for your time.
>
> Sincerely,
>
> Isaac Quintana, Research Assistant

Figure 3.1 Letter to Other DOT Agencies

Four of the 11 state agencies responded that they have looked at inclement weather signal timing. Below is a summary of the key information that Colorado, Maryland, and Ohio provided in response to the survey. The Minnesota DOT referred us to current research by Maki (1999). Although we have a research report from Alaska, their DOT agency did not respond to this survey. The survey responses are included in Appendix A.

The Colorado Department of Transportation (CDOT) reported that they have not studied signal timings in inclement weather. They have, however, modified signal timings at a few intersections on steep grades.

The Maryland State Highway Agency (Maryland SHA) currently is requesting funding from the FHWA to develop inclement weather signal timing plans similar to ours. The FHWA first stage comments to the proposal indicate that implementation of this concept has not been widely sought by local highway agencies and that they welcomed development of appropriate hardware. Maryland SHA currently is working with their existing signal and weather detection equipment vendors for incorporation of this concept as part of an "adaptive" timed demonstration signal system project.

The Ohio Department of Transportation (ODOT) agency commented that if a signal system is capable of operating in “traffic responsive” mode, then it is possible to setup multiple timing plans, which are activated when the operating speed at selected locations falls below pre-determined thresholds.

Chapter 4. Traffic Flow Parameters in Varying Weather Conditions

Data Collection

Some traffic flow characteristics change in inclement weather. In this study, observations are made of measured saturation flow, vehicle speed, and start-up lost in a range of weather conditions. These measurements are used first to determine how to change each parameter when developing the special timing plan and second, to determine under what conditions a special timing plan should be in operation. The measured parameters are defined as follows (FHWA 1994):

- **Saturation Flow Rate**: The maximum rate of traffic flow for a single lane under prevailing conditions if it has 100 percent effective green time (FHWA 1994).
- **Lost Time**: The time that an intersection is not being used by any movement. This occurs at the beginning of a movement and during the clearance intervals (FHWA 1994).
- **Free-flow speed**: The uninhibited speed of a vehicle on a length of roadway.

A range of seven weather severity categories is defined in Table 4.1. These are used consistently throughout the data collection and analysis and correspond to the categories used in the FHWA 1977 study.

Table 4.1 Scale of Road-Surface Weather Conditions

Severity ID	Description
1	Normal/Clear
2	Rain
3	Wet and Snowing
4	Wet and Slushy
5	Slushy in Wheel paths
6	Snowy and Sticking
7	Snow Packed surface

Saturation flow and speed data was collected during all available weather events over the winter season of 1999-2000. For comparison purposes, data also was collected in dry weather. On 14 different inclement weather days, more than 30 hours of saturation flow and free-flow speed information was collected. Data collection was collected primarily during the morning or evening peak hours. Due to unusually mild conditions during this season, there were only a few heavy snowstorms that occurred during peak hours, which limited data collection.

The two intersections selected for all data collection are: 700 East / 900 South and 1300 East / 500 South (Figure 4.1). The intersection geometries are shown in Figures 4.2 – 4.3. These two intersections were selected because they are on major corridors and near the University of Utah campus: 700E and 1300E are in the North-South direction with peak directional traffic into downtown (North) during the a.m. peak and from downtown (south) during the p.m. peak. Saturation flows were collected using JAMAR® TDC-8 traffic data collectors. Free-flow speeds were recorded with radar guns, while measuring the saturation flow.

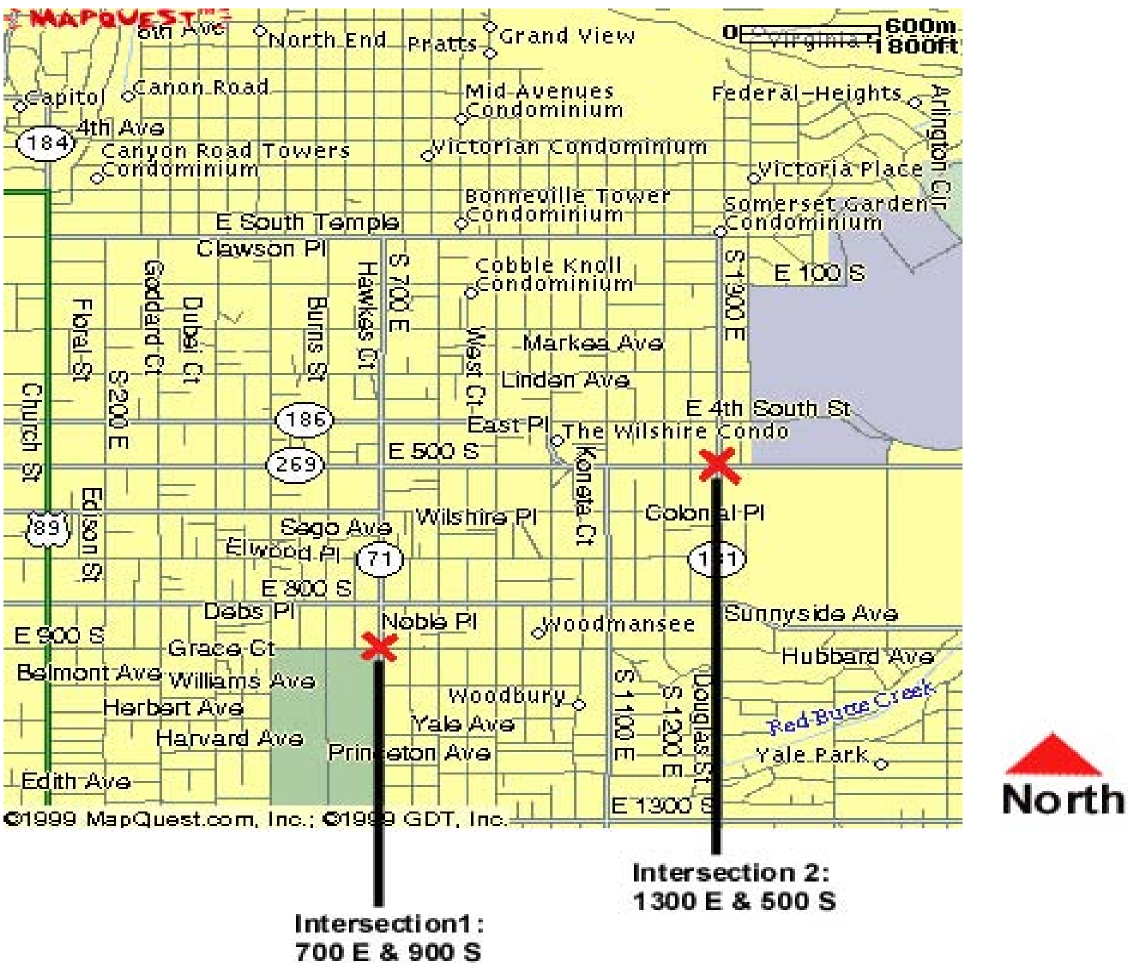


Figure 4.1 Study Area

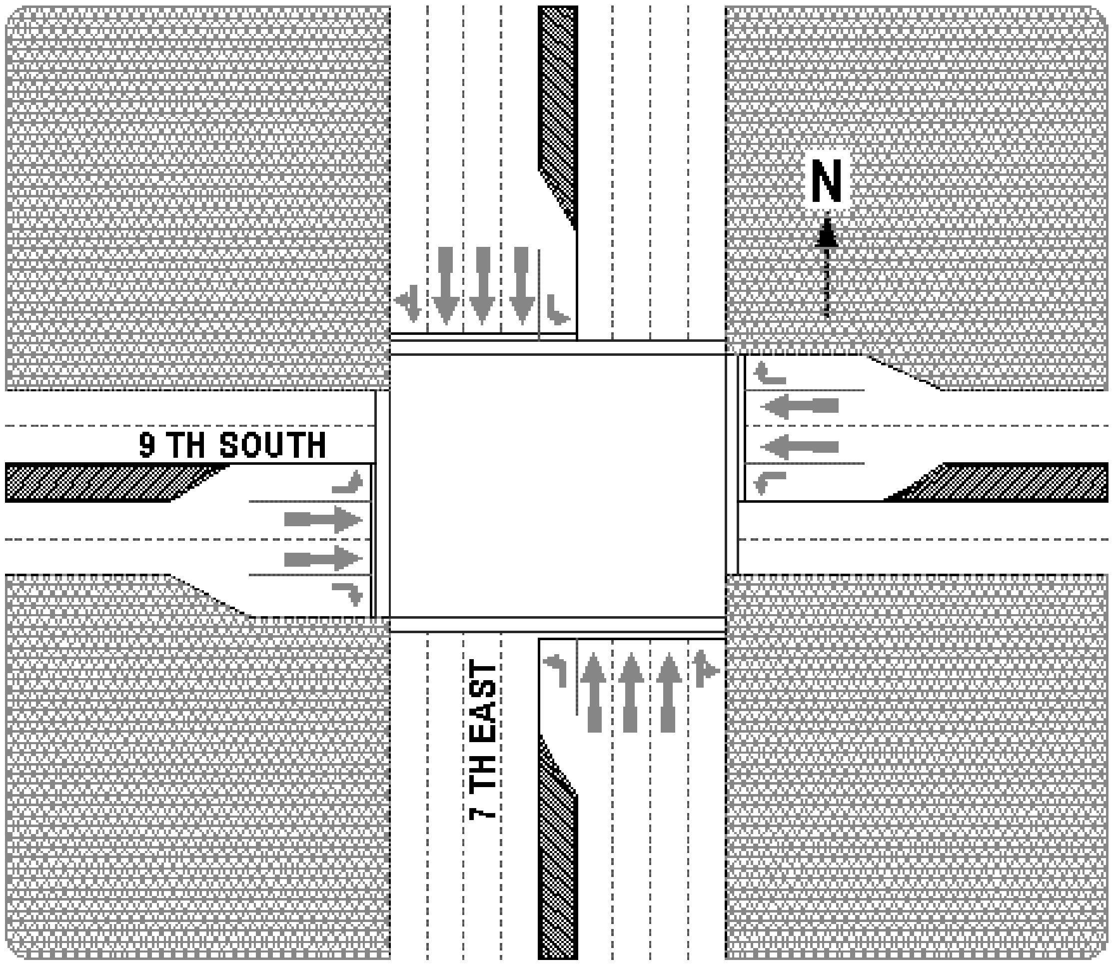


Figure 4.2 Intersection 1 (700 E & 900 So)

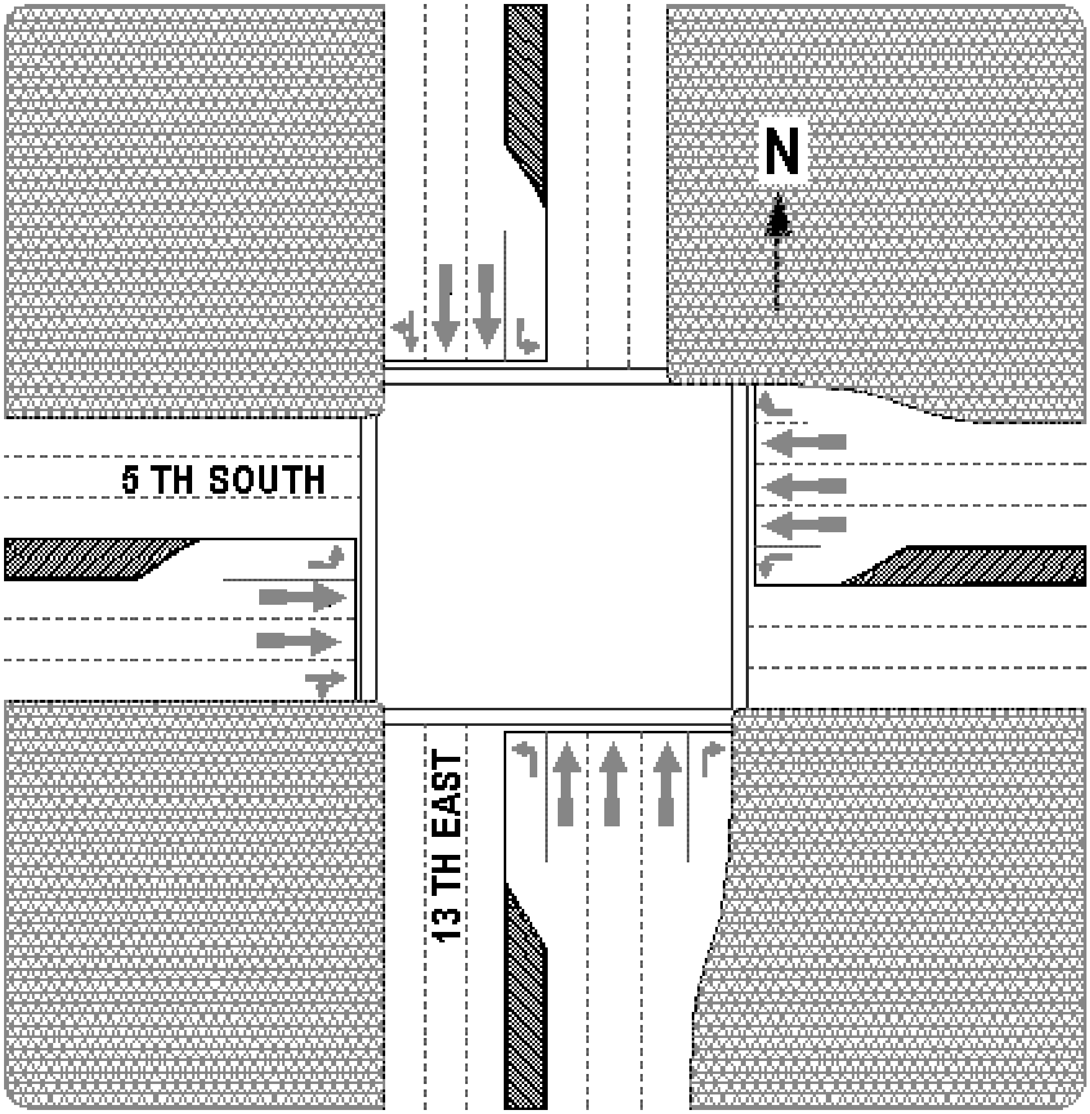


Figure 4.3 Intersection 2 (1300 E & 500 So)

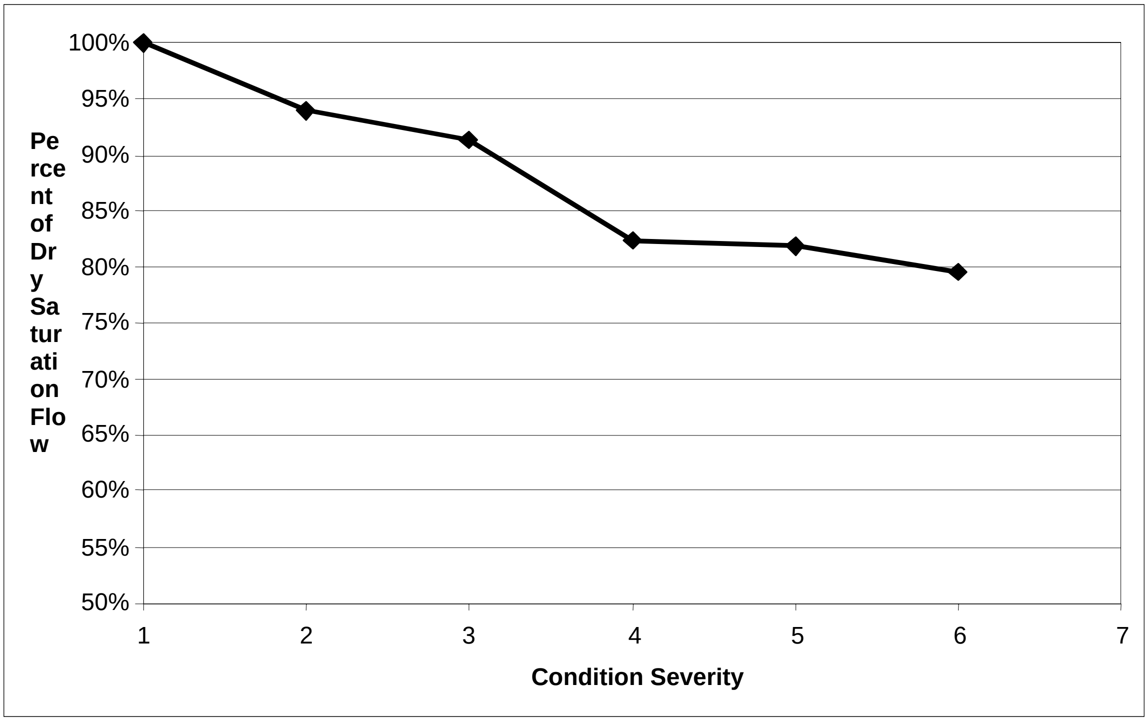
Saturation Flow

Saturation flow decreases during inclement weather because of larger headways, slower speeds, and decreased acceleration rates. The saturation flow decreased as storm severity increases. The average measured values are shown along with the percent reduction from the dry saturation flow as an average of all four approaches in Table 4.2. The percent deviation is shown graphically on Figure 4.4. The raw saturation flow values and the average values by approach are shown in Appendix B.

Table 4.2 Saturation Flow

Road Surface Condition	Severity	700 E 900 S (AM)	700 E 900 S (PM)	1300 E 500 S (AM)	1300 E 500 S (PM)	Average % Reduction
Dry	1	1881 (100%)	1736 (100%)	1752 (100%)	1902 (100%)	0%
Rain	2	1680 (89%)	1711 (99%)	-	-	6%
Wet and Snowing	3	1751 (93%)	1708 (98%)	1491 (85%)	1691 (89%)	11%
Wet and Slushy	4	-[a]	1476 (85%)	1321 (75%)	1647 (87%)	18%
Slushy in Wheel Paths	5	-	1421 (82%)	-	-	18%
Snowy and Sticking	6	-	-	1395 (80%)	-	20%
Snow Packed	7	-	-	-	-	-

[a] No data available



]

Figure 4.4 Average Saturation Flow Reductions by Weather Condition

No storms during this winter season were severe enough to be classified as severity category seven. Sufficient saturation flow data was collected for all other categories. It is important to note that the largest drop in percentage between two adjacent categories (3 and 4) is 9 percent. The maximum reduction in saturation flow was 20 percent, which occurred during severity category 6.

It is useful to compare our results to those found in similar studies. Three other studies also include saturation flow measurements in inclement weather. These are: Fairbanks, Alaska; Minneapolis, Minnesota; and Anchorage, Alaska. Each of these studies uses a slightly different definition for inclement weather conditions. The Anchorage study defines summer as the time when temperatures are above 14º F, on dry roads, or above 32º F on wet roads (without ice). Winter is defined as the time of year when temperatures range from -22º F to 14º F with dry pavement or with well-sanded hard-packed snow on the road. Extreme means the air temperature is below -22º F or during snowfall, blizzard, and/or freezing rain, resulting in slippery roads and reduced visibility. The Minneapolis study defines inclement as a storm with an accumulation of three inches or more. The Fairbanks study defines inclement as when residual ice, snow, or frost on the road surface due to a storm slows traffic. Although the definitions of inclement are slightly different for each study, we will show a comparison to observe that our results are in a similar range as other studies. The measured SLC inclement value of 1,432 is the mean saturation flow found between conditions 4-6. From saturation flow, a calculated headway change can be determined.

Table 4.3 Comparison of Saturation Flow Reduction

Weather Condition	Salt Lake City	*Flow Rates at signalized intersections in cold weather* (Botha and Kruse 1992) Fairbanks, AK	*Anchorage Signal timing report* (Bernardin, Lochmuller and Associates 1995) Anchorage, AK	*Adverse Weather Traffic Signal Timing* (Maki 1999) Minneapolis, MN
Normal/clear	*1,808	1,792	1,816	1,800
Inclement	1,432	1,538	1,600	1,600
Reduction	21%	14%	12%	11%

* values in vehicles per second

Table 4.4 Comparison of Headway Increase

Weather Condition	Salt Lake City	*Flow Rates at signalized intersections in cold weather* (Botha and Kruse 1992) Fairbanks, AK	*Anchorage Signal timing report* (Bernardin, Lochmuller and Associates 1995) Anchorage, AK	*Adverse Weather Traffic Signal Timing* (Maki 1999) Minneapolis, MN
Normal/clear	*1.99	2.00	1.98	2.00
Inclement	2.51	2.34	2.25	2.25
Increase	26%	17%	14%	13%

* values in seconds per vehicle

Speed

Free-flow speeds decrease during rain or snowstorm events. Speeds were collected during dry and inclement weather. Below are the average values of free-flow speeds collected on 18 different days during the winter of 1999-2000. Speed data was usually collected during the peak (AM or PM) hours at each intersection. There is no data, however, for speeds beyond condition 5 for either intersection. The complete set of speed data for each specific intersection approach and time is listed in Appendix C. The average speeds for each intersection are provided in Table 4.5. Figure 4.5 shows the percent reduction in speed from the dry condition in graphical form.

Table 4.5 Average Speeds and Percent Reduction from Dry Condition

Road Surface Condition	Severity	700 E 900 S (AM)	700 E 900 S (PM)	1300 E 500 S (AM)	1300 E 500 S (PM)	Average % Reduction
Dry	1	39.0 (100%)	31.4 (100%)	28.4 (100%)	27.4 (100%)	0%
Rain	2	34.3 (88%)	-	-	25.2 (92%)	10%
Wet and Snowing	3	31.4 (81%)	29.4 (93%)	-	23.5 (86%)	13%
Wet and Slushy	4	-*	22.0 (70%)	-	21.8 (79%)	25%
Slushy in Wheel Paths	5	25.5 (65%)	23.4 (75%)	-	-	30%
Snowy and Sticking	6	-	-	-	-	-
Snow Packed Surface	7	-	-	-	-	-

* No data available

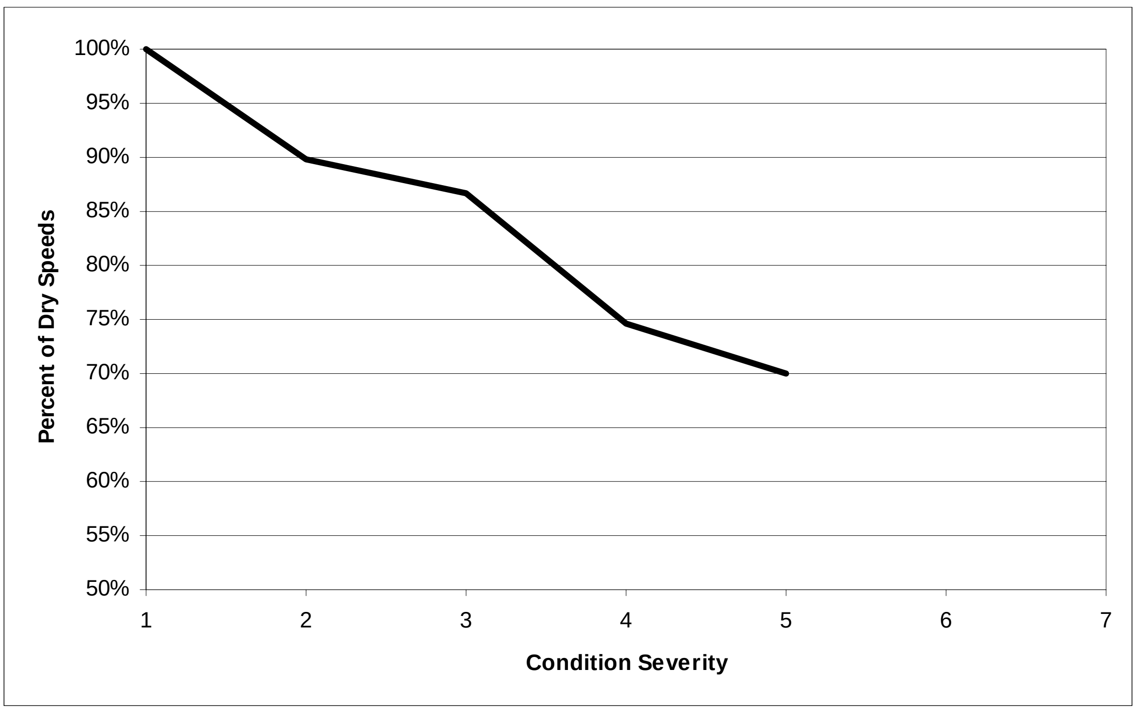


Figure 4.5 Average Speed Reductions by Condition

It is important to note that the largest drop in speeds is between conditions 3 and 4 (about 17 percent). This is consistent with the largest drop in saturation flows, which also saw the largest decrease between conditions 3 and 4. By condition 5, there was an average decrease in speeds of about 30 percent.

This decrease is consistent with two other studies. (Maki 1999) found a decrease in speeds of about 40 percent during inclement weather. (FHWA 1977) found that interstate speeds are reduced by 36 percent during inclement weather.

Table 4.6 shows the collected data of this study compared to the FHWA (1977) findings.

Table 4.6 Speed Data Comparison to FHWA (1977)

Condition	Severity	Percent Reduction (This Study)	Percent Reduction FHWA (1977)
Dry	1	0%	0%
Wet	2	10%	0%
Wet and Snowing	3	13%	13%
Wet and Slushy	4	25%	22%
Slushy in Wheel Paths	5	30%	30%
Snowy and Sticking	6	-	35%
Snowing and Packed	7	-	42%

The similarity in the results of the FHWA (1977) study indicates that our results are consistent with previous findings and increases our confidence in the data.

Start-Up Lost Time

Start-up lost time is based on the first four to five vehicles in a stopped queue. By the sixth vehicle, headways become more constant. The assumption is that lost time will increase with inclement weather. The start-up speeds of each queue (procession of cars) will be much slower during inclement weather because vehicles will have less tire traction, thus stalling their initial movements. The Anchorage, 1995 study found that inclement start-up times were equivalent to the summer conditions. They estimated that the additional time is accounted for in the saturation flow reductions and therefore no change to lost time was included in the revised signal timing. In Fairbanks, there was a small reduction but not appreciable from the two seconds recommended by the Highway Capacity Manual, 1985. MinnDOT (1999) found a 50 percent increase in start-up lost time from two to three seconds.

Based on our observations, the start-up lost time increased by an average of 23 percent from 2.0 to 2.46 seconds that corresponds to the increased headway for inclement saturation flow rates. This is based on 112 dry weather samples and 134 snowy (condition 4-6) samples. The rain (condition 2) seemed to have little impact on start-up lost time, as the 35 samples indicated that the average lost time changed from 2.0 seconds (dry) to 2.1 seconds (wet in conditions 2 and 3).

In addition to the start-up lost time, consideration must be given to the dilemma zone and amber time, all-red time and pedestrian crossing time.

Pedestrian Crossing Time

Knoblaugh et al (1996) identified that pedestrians, both young (under 65 years old) and older (65 years or older), increased their walking speed during inclement weather. Younger pedestrians increased by 9 percent from 4.82 feet per second (fps) to 5.24 fps while older pedestrians increased by 8 percent from 4.03 to 4.37 fps. Based on this research, the minimum crossing time to pedestrians should not change and therefore no impact to minimum signal timing restrictions exists.

Dilemma Zone, Amber and Red Time

While the discussion of start-up lost time indicates that reductions in intersection efficiency result, other factors also cause a decrease in intersection performance. Gap acceptance is reduced for permitted left turn movements primarily because of reduced traction. The updated 1997 HCM identifies the critical gap for left turns as being 4.1 seconds. While a gap acceptance study was outside the scope of this study, it clearly increased for severity levels 4 through 6. It is our opinion that there is a probable increase of 25 to 30 percent in critical gap time. There is, however, no substantial data to support this opinion.

Because of changes in traction, whether real or perceived, longer stopping distances are needed during the inclement weather. Typically this relates to drivers being more aware and cautious in their driving patterns. For a signalized intersection, the amount of amber time provided under dry conditions may not be sufficient to eliminate a potential dilemma zone in inclement conditions. Two factors contradict each other in determining the appropriate amber time. One is the decrease in speed, which reduces the needed amber time. The other is the reduction in deceleration rates, which causes the necessary amber time to increase. The following equation identifies the relationship in determining the appropriate amber time to eliminate dilemma zones.

$$\tau_{min} = \delta + \frac{W + L}{u_o} + \frac{u_o}{2a}$$

where:

τ_{min} = minimum amber time

δ = perception-reaction time

a = constant rate of braking deceleration (ft/s^2)

W = width of the intersection

L = length of the car

u_o = approach speed

According to Garber and Hoel (1988) the deceleration rate under normal conditions is 27 percent the gravitational acceleration (0.27*32.2 ft/sec^2 = 8.7 ft/sec^2). With decreased traction in snowy conditions, drivers tend to be more comfortable with 20 percent the gravitational constant (6.4 ft/sec^2). It is expected that for condition 7, snow packed roads, this deceleration rate may continue to decrease.

The 30 percent reduction in speed is not sufficient to account for the reduced deceleration and there is a resulting need for a 10 percent to 15 percent increase in amber time. For large intersections, more time is needed since the second term in the equation (clearing the intersection) is much greater with a wider intersection and yet slower speed with inclement weather. The needed increase typically is one-half to a whole second and therefore, is likely to have little effect on signal efficiency operations. It does, however, affect the dilemma zone and may have a substantial positive effect on reducing accidents. In addition to a reduced capacity for permitted left turn, the two sneakers are slower in clearing the intersection. Based on 136 observations during weather conditions 4 through 6, the sneakers took an average of 0.75 seconds longer to clear the intersection. Based on these findings, a one second increase in all-red time is recommended.

Chapter 5. Discussion

In section 4.2, the saturation flows and resulting headways of this research were compared to similar field values found in three other reports from the Literature Review. The purpose of this data comparison was not to validate results of any of the other three reports, but rather as a means to check the accuracy of the SLC field values. The winter of 2000 was one of the warmest on record and resulted in significantly fewer major snowfalls than most previous winters (National Climate Data Center, 2000). Therefore, very little traffic data was available for conditions beyond severity 6 in Salt Lake City. Below is a table summarizing the frequency of data collected for each weather condition.

Table 5.1 Data Points Collected by Severity category

Severity	1	2	3	4	5	6	7
Saturation flow	108	55	92	33	9	14	0
Speed	137	60	118	22	5	0	0

The point at which an inclement weather signal timing plan should be implemented is subjective. Although there may be ways to automate the decision process, more research would be required to make this a reality. Speed and saturation flow by severity saw the largest decrease between severity categories 3 and 4. Category 3 is defined as “wet and snowing,” and category 4 is defined as “wet and slushy”. The addition of slush to the roadway seemed to be the boundary where vehicles begin to see the largest decrease in performance. This is defined as the beginning point of inclement weather, or the point at which a modified signal timing plan becomes appropriate. The values for speeds and saturation flows that should be used in developing the inclement weather signal timing plan must be based on percent reductions found for the average reduction among severity categories 4-7. Since there was not enough data collected for speeds past severity category 5, that value should be used.

The question of when to implement the signal timing plan for the entire network is much more subjective and difficult to answer. This decision could be triggered by an automatic process whereby the saturation flow or speed is monitored and when thresholds are met, the inclement timing plans are implemented. It is recommend that the decision to implement the new signal timing plan be done by a trained operator or engineer.

As some of the literature suggests, some isolated intersections may have some need for inclement weather modifications. Intersections that may warrant more detailed consideration are those that have steeply graded approaches or approaches with dilemma zone issues.

There are some considerations in developing an automatic alarm system. Such a system could alert an operator of the possibility that an inclement weather signal timing plan may be effective. There are several ways this could be done. Since many of the corridors for which the plan will be developed are instrumented with speed detectors. These speed detectors could be used to alarm operators to take a closer look at the surface conditions. Although a previous study found that RWIS equipment data did not correlate well to road surface conditions (Maki 1999), this could be further developed and tested with the increasing capability of the equipment. The data could then be used in conjunction with the sensor data to trigger an alarm.

In this research, issues are presented and several recommendations are made for circumstances that warrant an inclement weather signal timing plan. The recommendations are based on collected data and other research on the topic. There are plans to verify the findings with modeling and simulation. Similar to Maki (1999), the necessary software has been procured along with data from past projects and present traffic counts and timing plans. This allows modeling of normal and inclement weather conditions on a local corridor. The results of the modeling will provide added value to this project and hopefully will validate the recommendations. The modeling results also will provide estimated benefits of using an inclement weather signal timing plan. Upon completion, the results of this modeling will be provided in a supplemental report.

In general, changing cycle lengths will not benefit inclement weather conditions. Although the reality is that there likely will be a different optimum cycle length, this is most likely due to changes in traffic volume and turning movement flows during inclement weather periods. This assumption is based on the observed volume reduction during the Minnesota research (Maki 1999). There is insufficient SLC data to provide a confident statement recommending a general reduced volume during inclement weather, since there are many other external factors that control volume trends, other than inclement weather. Therefore, unless specific inclement weather traffic flows are collected on each corridor, the cycle length is assumed to remain constant. Instead, the offsets, splits, and clearance interval times should be changed for the inclement weather plans.

It is of note that we are recommending the extension of amber and all-red times. The Anchorage study (Bernardin Lochmueller and Associates Inc.1995) stated that if they were to change the amber times, the amber time would be reduced because of lower speeds. This conclusion, however, is probably erroneous because the deceleration also is decreased due to lower traction. Because they decided that the amber times would probably be lower, they recommended against changing them, due to the liability of decreasing amber times. Our recommendations present no risk of increased liability because we are recommending an increase in amber time. The Minnesota Study (Maki 1999) did not offer any discussion on amber or all-red times.

Most traffic signal controllers only allow a single amber and all-red time, which is applied to all plans. These parameters are not easily changed along with split, cycle, and offset times. We maintain this recommendation, however, in anticipation of future ability to change these times.

Chapter 6. Conclusion and Recommendations

Our research investigates the effect of inclement weather on signalized traffic in Salt Lake City. Saturation flow, speed, and start-up lost times were measured during various weather severity levels at 700 East at 900 South and 1300 East at 500 South in Salt Lake City.

Based on current literature, contact with other state DOTs, and our own data collection, we conclude following:

- Saturation flows and speeds are reduced and start-up lost times are increased with severity of the road conditions. The greatest decrease in these values is found when slush begins to accumulate on the road surface.
- Several other studies examine the behavior of traffic signal timing systems during inclement weather or related topics. Most cold-weather states, however, do not modify their signal timings during inclement weather.
- A special signal timing plan should be implemented on major corridors throughout the Salt Lake Valley. Although this plan could be justified on safety considerations alone, such a plan should also provide some operational improvement (Maki 1999).

It is recommended that UDOT develop and use a signal timing plan for use in inclement weather. This plan easily can be developed, based on the collected data used to develop existing timings. The new signal timing plan should have the following characteristics:

- The plan should have new splits and offsets. Cycle lengths should remain the same unless inclement weather specific traffic counts are provided and indicate a different cycle is more appropriate.
- Increase amber time by 10 to 15 percent (one-half to one second) depending on intersection size. Half-second increase for intersections under 50 feet wide increasing to a one-second increase for intersections 100-feet wide.

- Increase all red time by one second to account for the slower clearing of the intersection by sneakers at permitted/protected intersections (taking 0.75 seconds longer than during dry conditions).
- Decrease the measured or calculated dry saturation flows by 20 percent
- Decrease the average dry speeds by 30 percent
- Start-up lost time should increase by 23 percent from 2.0 to 2.5 seconds.

It also has been determined:

- Gap acceptance time appears to increase by 25 to 30 percent, but this is an opinion as gap acceptance was outside the scope of this study.
- No change in pedestrian crossing timing needs is necessary based on prior research.
- Clearance intervals may be increased even further at intersections that have high speed or steep grade approaches.

The inclement weather signal timing plan should be activated based on engineering judgment. Four general areas should be considered when making this judgment to ensure that the plan provides sufficient benefit to the network. These areas are: severity, duration, area of influence, and traffic flows.

1. Severity. There should at least be slush on the road. Another measure of the severity might be to check on the current speeds. If the speeds fall below about 70 percent of normal (due to weather conditions), this could be used as a consideration for implementing a plan. Such information may be able to be derived from the TOC speed map.
2. Duration. The predicted duration of the storm must be sufficient to warrant the plan. Translating from one plan to another causes the network to be unable to recover quickly enough to benefit from a plan (Gartner, Stamatiadis, and Tarnoff 1995). It is therefore recommended that the storm be projected to continue to cause poor road conditions for at least 20 minutes to allow the network to recover from the transition. This will justify the plan’s disruption to traffic flow in the form of transition from one plan to another.

3. Area of Influence. The storm must influence a sufficient area. If the plan can be implemented by corridor, then the storm must be affecting a sufficient length of the corridor to be effective. What this length is will depend on engineering judgment at the time. This is an important part of the warrant because of the lake effect snowstorms that frequent the area.
4. Traffic Flows. Traffic conditions should be sufficient to warrant a new timing plan. These signal timing plans probably are most useful on a corridor basis, rather than a network-wide application. A.m. and p.m. peak plans are the most evident for which plans should be most effective. Mid-day plans also could be developed, depending on the demand and the perceived benefit the network or corridor might receive. Night or weekend plans may not receive as much benefit because of the decreased demand.

Attempt to determine the potential operational benefit from modeling and simulation are underway on sample downtown Salt Lake City corridors. This information will be provided in the form of a supplemental report upon completion.

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Appendix A. DOT Survey Results

Bob Snyder, MD 2/7/00

I'm Maryland State Highway Administration's Traffic Operations Assistant Chief. I've recently prepared the attached first and second stage NCHRP project funding requests to accomplish on the street just what you are considering.

Our funding request has taken for granted the need for such timing efforts based upon a search of the current literature. Further, the first stage comments received from several FHWA sources indicated implementation of this concept has not been widely sought after by local highway agencies, but its hardware development was welcomed by the FHWA.

In any case, my agency is working with our existing signal and weather detection equipment vendors for incorporation of this concept as part of an "adaptive" timed demonstration signal system project.

If you have a questions, please E Mail me at bsnyder@sha.state.md.us or contact me by telephone at 410.787.7631.

Linda Voss KS 2/7/00

No we have never researched this issue and do not plan to. Linda Voss, State Traffic Engineer, Kansas DOT

Ken Greene OH (Dist 4) 2/7/00

District 4 of the Ohio DOT covers the northeast corner of the state, Ashtabula to Canton. Our heaviest snowfall is concentrated in Ashtabula County just off Lake Erie. It is a rural county with few, 22, signals maintained by the DOT. The majority of our district receives only moderate snowfall. Our snow and ice operations are usually very good at keeping the roadways clear. This results in travel impacts usually being of rather short duration. While any severe weather undoubtedly affects travel patterns, we (to the best of my knowledge) have not studied nor considered alternate signal timing under these conditions.

Kenneth Greene, P.E. Traffic Maintenance Engineer ODOT D-4

330-297-0801 x-305

Phil Stormer OH 2/7/00

I am not aware of any studies by the Ohio Department of Transportation on this subject. I am sending a copy of this response to Bob Yankovich who is the Administrator of the Office of Traffic Engineering in ODOT's Central Office. He may be aware of research or other interest in this area. I have the following comments on this topic: If you have a signal system that is capable of operating in traffic responsive mode then you may be able to setup multiple timing plans that are activated when the operating speed at selected locations falls below preselected levels. The reduced speed timing plans could be calculated using any software program that uses operating speed as an input value. Also using a software package, typically simulation programs, that allows the selection of vehicle and driver characteristics will help you to customize the driver actions to reflect to the pavement conditions. I realize that this is a different approach than the one you described in your email but if the signal system is capable of selecting timing plans that automatically accommodate various operating speeds in addition to volume, occupancy, and etc. then it may not be necessary to rigorously quantify the changes caused by rain/snow.

Please contact me if you have any questions.

Phil Stormer

Traffic Studies Engineer

Voice: 937.497.6887

FAX: 937.497.6870

email, work: pstormer@dot.state.oh.us

email, home: pstormer@wesnet.com

Sandy Myers VA 2/8/00

This reply comes from the Virginia Department of Transportation's Staunton District - which primarily consists of the Shenandoah Valley.

Our response to this problem would be using video cameras. Using the Max II times during inclement weather. Do you have any comments to provide? Thanks for your question. I am sure you will receive several suggestions.

Sandy Myers

Public Relations Coordinator

VDOT Staunton District

(540) 332-9075

Carl Sorrentino CO 2/8/00

Colorado DOT hasn't done a study or systematic plan for changing traffic signals in response to inclement weather. Once or twice a winter, at a handful of locations, we have done minor "tweaking" of signal timing where ice on a grade slows the progress of vehicles given their green light. That's about all.

John Perkins VT 2/8/00

I have asked the sections that work on our signals and they have no knowledge of any work being done to change signal timings because of weather related causes.

From: Blondin, EJ

Sent: Monday, February 07, 2000 10:52 AM

To: Kreis, Ann

Subject: RE: Inquiring about research done by your state agency

At this time we are not changing our signal timing plans for heavy snow or any other weather conditions. We do change our signal timing plans for time of day conditions ie. AM, PM, and Off Peak. I do not know of any plans to study the kind of things mentioned in UDOT's e-mail.

Gary Ries MN 2/8/00

Our Metro Division hired a consultant to do a study of inclement winter weather on a signalized corridor. As I recall, the results of the study were not definitive. I don't know if they're considering additional study. Your best contact for a copy of the results, or for questions, is Bev Farraher, beverly.farraher@dot.state.mn.us In the course of doing a literature search for this study, an interesting document surfaced from Anchorage, dated March 1995. You may be able to get a copy from Alaska DOT, or Bev can probably xerox a copy for you. The only other thing that Mn/DOT has done, that I'm familiar with, is a study of the impact of weather on freeway capacity. This, of course, is an unsignalized condition. The study did show the degradation of freeway capacity per incremental differences in rain or snow fall. If you have any need for this, your library can probably borrow it from Mn/DOT's library (Impact of Weather on Freeway Capacity, January 1981, Gary L. Ries), or I can send you a Xerox. Again, this is not a study of a signalized condition, and so may not be useful.

Doug Tomlinson, PA 2/10/00

This is in response to your email requesting information concerning the use of alternate signal timing plans during inclement weather. In Pennsylvania, the local municipalities own, operate, and maintain traffic signals in their jurisdiction. To our knowledge, no municipality has used, or has plans to use, alternate timing plans for inclement weather. If I can be of any further assistance, please contact me at the following location:

Douglas Tomlinson

Pennsylvania DOT

P.O. Box 2047

Harrisburg, PA 17105-2047

Phone: 717-787-3657

Fax: 717-783-8012

email: dmt101@hotmail.com

Michael Kyte, ID 2/10/00

Your request was forwarded to me by Larry Van Over from the Idaho TRansportation Department. Just by way of background, I serve as a member of the Highway Capacity Committee at TRB. There has been some research done on the reduction of free flow speeds due to bad weather on interstate highways. I will check to see if there is also work at signalized intersections in bad weather.

best regards,

Michael Kyte, Director

National Institute for Advanced Transportation Technology

University of Idaho

Moscow, ID 83844-0901

208-885-6002 (voice)

208-885-2877 (fax)

mkyte@uidaho.edu

Rebecca Bowden, MI 2/16/00

Director DeSana asked me to respond to your inquiry regarding snowfall and how it affects intersection timing. After contacting Tom Rathbun I was able to determine that Michigan does not use special timing for intersections when there is snow. Although we do get snow it is often infrequent and does not seem to affect traffic severely. If you do have further questions you could contact Tom Rathbun at 517-373-2324.

He would be the gentleman in charge of this function if Michigan used it.

Appendix B. Saturation Flow Data

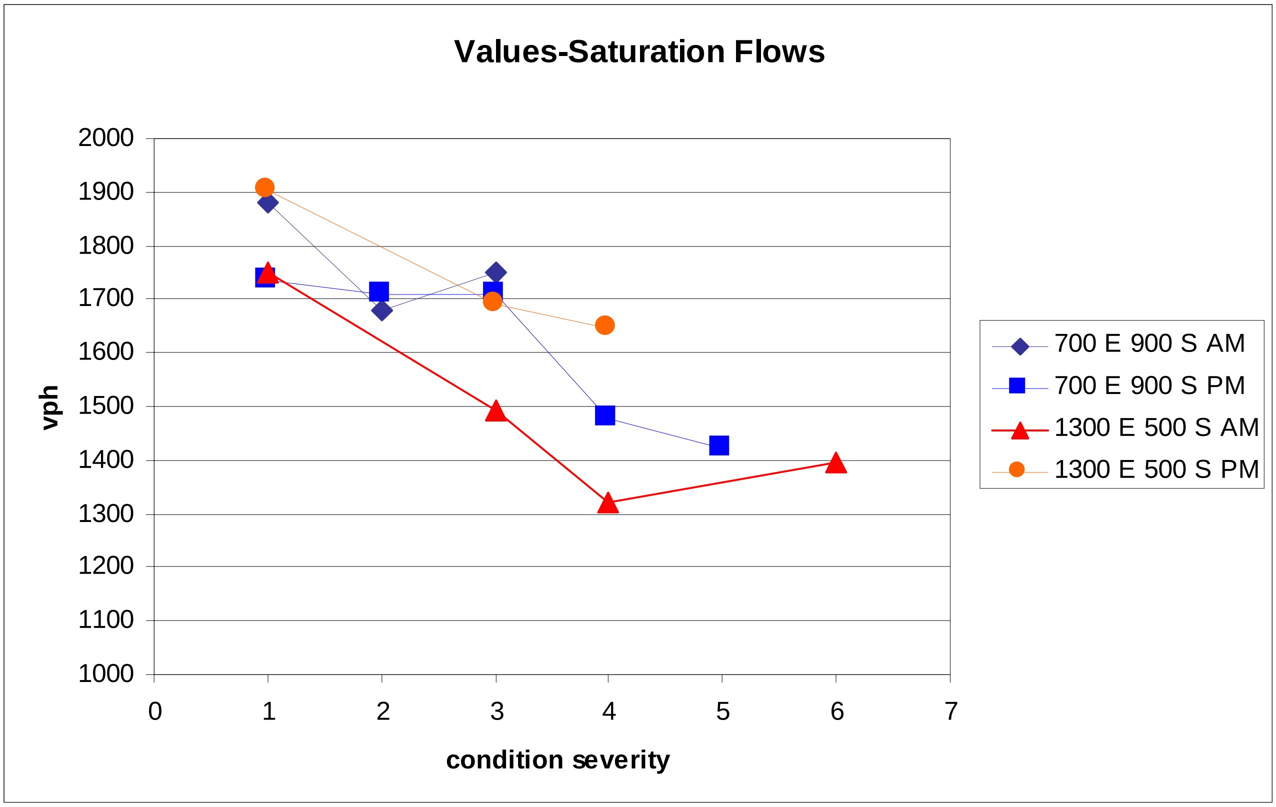

Figure B1 Average Saturation flows per street

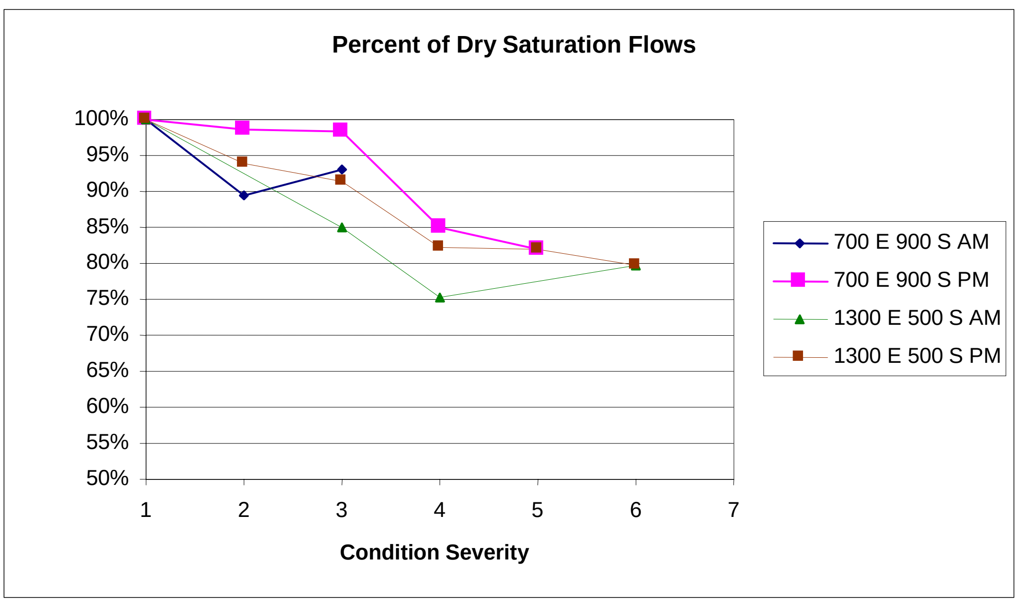

Figure B2 Percent of Normal/clear Saturation Flows

Date	Time	Sat Flow*	Location	Direction	Condition	Queue Length
12/23/1999	7:52 AM	1682	13th&5th	North	1	7
12/23/1999	7:55 AM	1570	13th&5th	North	1	5
12/23/1999	8:10 AM	1610	13th&5th	North	1	5
02/17/1999	8:20 AM	1807	13th&5th	North	1	9
02/17/1999	8:22 AM	1559	13th&5th	North	1	6
02/17/1999	8:25 AM	1691	13th&5th	North	1	10
02/17/1999	8:29 AM	1970	13th&5th	North	1	9
02/17/1999	8:34 AM	1803	13th&5th	North	1	9
02/17/1999	8:35 AM	1738	13th&5th	North	1	7
02/17/1999	8:39 AM	1937	13th&5th	North	1	14
02/17/1999	8:40 AM	1794	13th&5th	North	1	5
02/17/1999	8:42 AM	1995	13th&5th	North	1	8
02/17/1999	8:47 AM	1693	13th&5th	North	1	8
02/17/1999	8:49 AM	1837	13th&5th	North	1	7
02/17/1999	8:51 AM	1796	13th&5th	North	1	6
02/17/1999	8:52 AM	1742	13th&5th	North	1	4
02/17/1999	8:55 AM	1962	13th&5th	North	1	7
02/17/1999	8:58 AM	1789	13th&5th	North	1	6
02/17/1999	9:02 AM	1313	13th&5th	North	1	5
02/17/1999	9:07 AM	1748	13th&5th	North	1	5
12/20/1999	4:41 PM	2024	13th&5th	South	1	5
12/20/1999	4:42 PM	1869	13th&5th	South	1	5
12/20/1999	4:50 PM	1719	13th&5th	South	1	9

12/20/1999 4:54 PM	1831	13th&5th	South	1	6
12/20/1999 4:55 PM	1854	13th&5th	South	1	4
12/20/1999 4:56 PM	2137	13th&5th	South	1	5
12/20/1999 4:59 PM	2042	13th&5th	South	1	6
12/20/1999 5:02 PM	2204	13th&5th	South	1	5
12/20/1999 5:04 PM	1899	13th&5th	South	1	4
12/20/1999 5:05 PM	1878	13th&5th	South	1	9
12/20/1999 5:08 PM	1916	13th&5th	South	1	8
12/20/1999 5:10 PM	2100	13th&5th	South	1	11
12/20/1999 5:13 PM	1697	13th&5th	South	1	4
12/20/1999 5:15 PM	1895	13th&5th	South	1	6
12/20/1999 5:16 PM	1889	13th&5th	South	1	9
12/20/1999 5:18 PM	2035	13th&5th	South	1	7
12/20/1999 5:19 PM	1824	13th&5th	South	1	6
12/20/1999 5:21 PM	2157	13th&5th	South	1	6
12/20/1999 5:23 PM	1742	13th&5th	South	1	4
12/20/1999 5:25 PM	1812	13th&5th	South	1	16
12/20/1999 5:26 PM	1722	13th&5th	South	1	6
02/10/2000 5:08 PM	2098	13th&5th	South	1	10
02/10/2000 5:10 PM	1670	13th&5th	South	1	9
02/10/2000 5:12 PM	1931	13th&5th	South	1	8
02/10/2000 5:14 PM	1846	13th&5th	South	1	13
02/10/2000 5:16 PM	2081	13th&5th	South	1	15
02/10/2000 5:18 PM	1889	13th&5th	South	1	9
02/10/2000 5:20 PM	2156	13th&5th	South	1	12

02/10/2000 5:22 PM	2024	13th&5th	South	1	9
02/10/2000 5:24 PM	1778	13th&5th	South	1	8
02/10/2000 5:26 PM	1784	13th&5th	South	1	8
02/10/2000 5:28 PM	1566	13th&5th	South	1	8
02/10/2000 5:30 PM	1754	13th&5th	South	1	9
02/10/2000 5:32 PM	1963	13th&5th	South	1	13
02/10/2000 5:34 PM	2015	13th&5th	South	1	4
02/10/2000 5:35 PM	1589	13th&5th	South	1	7
02/10/2000 5:37 PM	1770	13th&5th	South	1	7
02/10/2000 5:52 PM	1686	13th&5th	South	1	10
02/10/2000 5:54 PM	2056	13th&5th	South	1	11
02/10/2000 5:56 PM	1825	13th&5th	South	1	5
02/10/2000 5:59 PM	2079	13th&5th	South	1	6
02/10/2000 6:03 PM	1947	13th&5th	South	1	6
02/10/2000 6:06 PM	2024	13th&5th	South	1	6
02/10/2000 6:08 PM	1812	13th&5th	South	1	5
02/10/2000 6:12 PM	1965	13th&5th	South	1	9
02/10/2000 6:16 PM	1936	13th&5th	South	1	8
12/22/1999 7:43 AM	1841	7th&9th	North	1	6
12/22/1999 7:45 AM	1815	7th&9th	North	1	10
12/22/1999 7:47 AM	1870	7th&9th	North	1	10
12/22/1999 7:49 AM	1977	7th&9th	North	1	10
12/22/1999 7:50 AM	1815	7th&9th	North	1	10
12/22/1999 7:52 AM	1702	7th&9th	North	1	10
12/22/1999 7:54 AM	2015	7th&9th	North	1	10

12/22/1999 7:56 AM	1740	7th&9th	North	1	10
12/22/1999 7:57 AM	2093	7th&9th	North	1	6
12/22/1999 7:59 AM	1828	7th&9th	North	1	6
12/22/1999 8:03 AM	1892	7th&9th	North	1	4
12/22/1999 8:10 AM	2006	7th&9th	North	1	6
12/22/1999 8:11 AM	1961	7th&9th	North	1	5
12/22/1999 8:13 AM	2083	7th&9th	North	1	10
12/22/1999 8:15 AM	1884	7th&9th	North	1	10
12/22/1999 8:17 AM	1917	7th&9th	North	1	10
12/22/1999 8:19 AM	1839	7th&9th	North	1	10
12/22/1999 8:20 AM	2077	7th&9th	North	1	11
12/22/1999 8:22 AM	1883	7th&9th	North	1	9
12/22/1999 8:24 AM	1687	7th&9th	North	1	9
12/22/1999 8:26 AM	1903	7th&9th	North	1	10
12/22/1999 8:28 AM	1934	7th&9th	North	1	11
12/22/1999 8:29 AM	1837	7th&9th	North	1	7
12/20/1999 5:02 PM	1716	7th&9th	South	1	8
12/20/1999 5:04 PM	1660	7th&9th	South	1	5
12/20/1999 5:05 PM	1605	7th&9th	South	1	10
12/20/1999 5:07 PM	1752	7th&9th	South	1	5
12/20/1999 5:10 PM	1686	7th&9th	South	1	10
12/20/1999 5:12 PM	1740	7th&9th	South	1	10
12/20/1999 5:14 PM	1895	7th&9th	South	1	10
12/20/1999 5:15 PM	1688	7th&9th	South	1	6
12/20/1999 5:17 PM	1609	7th&9th	South	1	8

12/20/1999 5:19 PM	1895	7th&9th	South	1	10
12/20/1999 5:20 PM	1632	7th&9th	South	1	10
12/20/1999 5:22 PM	1636	7th&9th	South	1	5
12/20/1999 5:27 PM	1876	7th&9th	South	1	8
12/20/1999 5:30 PM	1733	7th&9th	South	1	9
12/20/1999 5:32 PM	1882	7th&9th	South	1	10
12/20/1999 5:34 PM	1684	7th&9th	South	1	10
12/20/1999 5:35 PM	1697	7th&9th	South	1	4
12/20/1999 5:37 PM	1615	7th&9th	South	1	8
12/20/1999 5:39 PM	1972	7th&9th	South	1	10
12/20/1999 5:40 PM	1742	7th&9th	South	1	4
05/08/2000 10:47 AM	1468	7th&9th	South	2	6
05/08/2000 10:48 AM	1586	7th&9th	South	2	6
05/08/2000 10:51 AM	1768	7th&9th	South	2	6
05/08/2000 10:53 AM	1511	7th&9th	South	2	6
05/08/2000 10:54 AM	1748	7th&9th	South	2	6
05/08/2000 10:56 AM	1451	7th&9th	South	2	5
05/08/2000 10:57 AM	1902	7th&9th	South	2	5
05/08/2000 11:04 AM	1732	7th&9th	South	2	7
05/08/2000 11:07 AM	1831	7th&9th	South	2	6
05/08/2000 11:09 AM	2002	7th&9th	South	2	6
05/08/2000 11:10 AM	1735	7th&9th	South	2	8
05/08/2000 11:12 AM	1663	7th&9th	South	2	7
05/08/2000 11:13 AM	1693	7th&9th	South	2	7
05/08/2000 11:15 AM	1586	7th&9th	South	2	7

05/08/2000 11:18 AM	1636	7th&9th	South	2	6
05/08/2000 11:19 AM	1989	7th&9th	South	2	7
05/08/2000 11:21 AM	1735	7th&9th	South	2	7
05/08/2000 11:23 AM	1533	7th&9th	South	2	7
05/08/2000 11:24 AM	1995	7th&9th	South	2	6
05/08/2000 11:26 AM	1546	7th&9th	South	2	7
05/08/2000 11:27 AM	1525	7th&9th	South	2	7
05/08/2000 11:29 AM	1526	7th&9th	South	2	8
05/08/2000 11:30 AM	1752	7th&9th	South	2	7
05/08/2000 11:32 AM	1404	7th&9th	South	2	6
05/08/2000 11:34 AM	1473	7th&9th	South	2	11
05/08/2000 11:35 AM	1668	7th&9th	South	2	7
05/08/2000 11:37 AM	1701	7th&9th	South	2	6
05/08/2000 11:38 AM	1978	7th&9th	South	2	8
05/08/2000 11:40 AM	1633	7th&9th	South	2	6
05/08/2000 11:41 AM	1766	7th&9th	South	2	7
05/08/2000 11:43 AM	1484	7th&9th	South	2	6
05/08/2000 11:45 AM	1780	7th&9th	South	2	5
05/08/2000 11:48 AM	1648	7th&9th	South	2	5
05/25/2000 6:40 PM	1616	7th&9th	South	2	6
05/25/2000 6:44 PM	1692	7th&9th	South	2	8
05/25/2000 6:46 PM	1666	7th&9th	South	2	13
05/25/2000 6:48 PM	1648	7th&9th	South	2	16
05/25/2000 6:53 PM	1658	7th&9th	South	2	16
05/25/2000 6:54 PM	1652	7th&9th	South	2	13

05/25/2000 7:05 PM	1657	7th&9th	South	2	11
05/25/2000 7:05 PM	1768	7th&9th	South	2	4
05/25/2000 7:08 PM	1748	7th&9th	South	2	4
05/25/2000 7:16 PM	1636	7th&9th	South	2	11
05/25/2000 7:24 PM	1887	7th&9th	South	2	12
05/25/2000 7:26 PM	1762	7th&9th	South	2	8
05/25/2000 7:26 PM	1898	7th&9th	South	2	13
05/25/2000 7:28 PM	1878	7th&9th	South	2	12
05/25/2000 7:28 PM	1766	7th&9th	South	2	6
05/25/2000 7:30 PM	1717	7th&9th	South	2	13
05/25/2000 7:31 PM	1576	7th&9th	South	2	13
05/25/2000 7:31 PM	1602	7th&9th	South	2	12
05/25/2000 7:32 PM	1618	7th&9th	South	2	6
05/25/2000 7:33 PM	1722	7th&9th	South	2	13
05/25/2000 7:35 PM	1717	7th&9th	South	2	10
05/25/2000 7:40 PM	1680	7th&9th	South	2	6
05/25/2000 7:42 PM	1779	7th&9th	South	2	10
01/10/2000 8:40 AM	1214	13th&5th	North	3	10
01/10/2000 8:41 AM	1376	13th&5th	North	3	13
01/10/2000 8:43 AM	1811	13th&5th	North	3	10
01/10/2000 8:47 AM	1563	13th&5th	North	3	7
02/17/2000 4:20 PM	1697	13th&5th	South	3	3
02/17/2000 4:24 PM	1989	13th&5th	South	3	6
02/17/2000 4:28 PM	1602	13th&5th	South	3	6
02/17/2000 4:40 PM	1693	13th&5th	South	3	9

02/17/2000 4:41 PM	1628	13th&5th	South	3	10
02/17/2000 4:43 PM	1578	13th&5th	South	3	7
02/17/2000 4:44 PM	1575	13th&5th	South	3	6
02/17/2000 5:04 PM	1838	13th&5th	South	3	4
02/17/2000 5:08 PM	1777	13th&5th	South	3	10
02/17/2000 5:10 PM	1869	13th&5th	South	3	10
02/17/2000 5:11 PM	1881	13th&5th	South	3	5
02/17/2000 5:15 PM	1523	13th&5th	South	3	6
02/17/2000 5:21 PM	1804	13th&5th	South	3	15
02/17/2000 5:22 PM	1980	13th&5th	South	3	11
02/17/2000 5:24 PM	1817	13th&5th	South	3	10
02/17/2000 5:26 PM	1716	13th&5th	South	3	8
02/17/2000 5:30 PM	1946	13th&5th	South	3	8
02/17/2000 5:31 PM	1854	13th&5th	South	3	4
02/24/2000 1:07 PM	1692	13th&5th	South	3	6
02/24/2000 1:10 PM	1220	13th&5th	South	3	5
02/24/2000 1:12 PM	1500	13th&5th	South	3	8
02/24/2000 1:15 PM	2060	13th&5th	South	3	4
02/24/2000 1:16 PM	1407	13th&5th	South	3	4
02/24/2000 1:18 PM	1511	13th&5th	South	3	6
02/24/2000 1:19 PM	1385	13th&5th	South	3	6
02/24/2000 1:22 PM	1421	13th&5th	South	3	6
01/10/2000 8:28 AM	1381	7th&9th	North	3	12
01/10/2000 8:30 AM	1568	7th&9th	North	3	10
01/10/2000 8:31 AM	1867	7th&9th	North	3	12

01/10/2000 8:33 AM	1724	7th&9th	North	3	12
01/10/2000 8:37 AM	1775	7th&9th	North	3	13
01/10/2000 8:38 AM	1795	7th&9th	North	3	12
01/10/2000 8:40 AM	1663	7th&9th	North	3	10
01/10/2000 8:42 AM	1656	7th&9th	North	3	12
01/10/2000 8:44 AM	1486	7th&9th	North	3	12
01/10/2000 8:46 AM	1770	7th&9th	North	3	12
01/10/2000 8:47 AM	1785	7th&9th	North	3	12
01/10/2000 8:49 AM	1861	7th&9th	North	3	12
01/10/2000 8:51 AM	1481	7th&9th	North	3	12
01/10/2000 8:53 AM	1593	7th&9th	North	3	10
01/10/2000 8:54 AM	1807	7th&9th	North	3	12
01/10/2000 8:56 AM	1846	7th&9th	North	3	12
01/10/2000 8:58 AM	1721	7th&9th	North	3	12
01/10/2000 9:00 AM	1743	7th&9th	North	3	10
01/10/2000 9:01 AM	1783	7th&9th	North	3	12
01/10/2000 9:03 AM	1891	7th&9th	North	3	12
01/10/2000 9:05 AM	1956	7th&9th	North	3	12
01/10/2000 9:07 AM	1810	7th&9th	North	3	12
01/10/2000 9:09 AM	1777	7th&9th	North	3	12
01/10/2000 9:10 AM	1576	7th&9th	North	3	10
01/10/2000 9:12 AM	1889	7th&9th	North	3	10
01/10/2000 9:14 AM	1717	7th&9th	North	3	10
01/10/2000 9:16 AM	2034	7th&9th	North	3	12
01/10/2000 9:17 AM	1973	7th&9th	North	3	6

01/10/2000 9:19 AM	1680	7th&9th	North	3	6
01/10/2000 9:21 AM	1916	7th&9th	North	3	8
01/10/2000 9:23 AM	1533	7th&9th	North	3	9
02/17/2000 3:47 PM	1737	7th&9th	South	3	12
02/17/2000 3:49 PM	1538	7th&9th	South	3	8
02/17/2000 3:51 PM	1581	7th&9th	South	3	12
02/17/2000 3:53 PM	1945	7th&9th	South	3	13
02/17/2000 3:55 PM	1737	7th&9th	South	3	13
02/17/2000 3:58 PM	1679	7th&9th	South	3	8
02/17/2000 4:00 PM	1599	7th&9th	South	3	8
02/17/2000 4:01 PM	1590	7th&9th	South	3	9
02/17/2000 4:03 PM	1528	7th&9th	South	3	5
02/17/2000 4:05 PM	1945	7th&9th	South	3	5
02/17/2000 4:06 PM	1619	7th&9th	South	3	8
02/17/2000 4:08 PM	2066	7th&9th	South	3	9
02/17/2000 4:10 PM	1819	7th&9th	South	3	13
02/17/2000 4:11 PM	1668	7th&9th	South	3	6
02/17/2000 4:13 PM	1511	7th&9th	South	3	6
02/17/2000 4:14 PM	1497	7th&9th	South	3	8
02/17/2000 4:16 PM	1882	7th&9th	South	3	8
02/17/2000 4:18 PM	1757	7th&9th	South	3	6
02/17/2000 4:19 PM	1775	7th&9th	South	3	13
02/17/2000 4:21 PM	1541	7th&9th	South	3	11
02/17/2000 4:23 PM	1578	7th&9th	South	3	11
02/17/2000 4:25 PM	1587	7th&9th	South	3	10

02/17/2000 4:26 PM	1642	7th&9th	South	3	10
02/17/2000 4:28 PM	1839	7th&9th	South	3	13
02/17/2000 4:30 PM	1937	7th&9th	South	3	8
02/17/2000 4:33 PM	1678	7th&9th	South	3	9
02/17/2000 4:34 PM	1762	7th&9th	South	3	8
02/17/2000 4:36 PM	1766	7th&9th	South	3	6
02/17/2000 4:38 PM	1672	7th&9th	South	3	10
02/17/2000 4:40 PM	1618	7th&9th	South	3	6
02/17/2000 4:41 PM	1841	7th&9th	South	3	6
01/10/2000 8:30 AM	1148	13th&5th	North	4	6
01/10/2000 8:33 AM	1351	13th&5th	North	4	8
01/10/2000 8:34 AM	1219	13th&5th	North	4	8
01/10/2000 8:36 AM	1481	13th&5th	North	4	7
01/10/2000 8:38 AM	1405	13th&5th	North	4	9
02/24/2000 1:04 PM	1762	13th&5th	South	4	5
02/24/2000 1:06 PM	1173	13th&5th	South	4	5
02/24/2000 1:13 PM	1731	13th&5th	South	4	6
02/24/2000 1:29 PM	1489	13th&5th	South	4	5
02/24/2000 1:36 PM	2079	13th&5th	South	4	5
02/24/2000 2:06 PM	1193	7th&9th	South	4	5
02/24/2000 2:07 PM	1595	7th&9th	South	4	9
02/24/2000 2:08 PM	1947	7th&9th	South	4	5
02/24/2000 2:10 PM	1350	7th&9th	South	4	7
02/24/2000 2:12 PM	1867	7th&9th	South	4	13
02/24/2000 2:13 PM	1307	7th&9th	South	4	12

02/24/2000 2:15 PM	1128	7th&9th	South	4	17
02/24/2000 2:16 PM	1340	7th&9th	South	4	14
02/24/2000 2:23 PM	1365	7th&9th	South	4	14
02/24/2000 2:24 PM	1477	7th&9th	South	4	6
02/24/2000 2:30 PM	1457	7th&9th	South	4	9
02/24/2000 2:34 PM	1424	7th&9th	South	4	7
02/24/2000 2:35 PM	1735	7th&9th	South	4	10
01/10/2000 8:17 AM	1819	7th&9th	North	5	12
01/10/2000 8:19 AM	1838	7th&9th	North	5	12
01/10/2000 8:21 AM	1765	7th&9th	North	5	12
01/10/2000 8:24 AM	1582	7th&9th	North	5	10
02/24/2000 2:18 PM	1443	7th&9th	South	5	22
02/24/2000 2:20 PM	1461	7th&9th	South	5	10
02/24/2000 2:21 PM	1304	7th&9th	South	5	4
02/24/2000 2:26 PM	1409	7th&9th	South	5	11
02/24/2000 2:27 PM	1462	7th&9th	South	5	18
02/24/2000 2:29 PM	1447	7th&9th	South	5	7
01/10/2000 8:20 AM	1296	13th&5th	North	6	9
01/10/2000 8:22 AM	1394	13th&5th	North	6	12
01/10/2000 8:24 AM	1669	13th&5th	North	6	6
01/10/2000 8:26 AM	1194	13th&5th	North	6	6
01/10/2000 8:27 AM	1126	13th&5th	North	6	4
01/10/2000 8:29 AM	1530	13th&5th	North	6	9
01/10/2000 8:52 AM	1210	13th&5th	North	6	6
01/10/2000 8:53 AM	1250	13th&5th	North	6	7

01/10/2000 8:55 AM	1223	13th&5th	North	6	5
01/10/2000 8:58 AM	1851	13th&5th	North	6	5
01/10/2000 9:00 AM	1582	13th&5th	North	6	8
01/10/2000 9:01 AM	1403	13th&5th	North	6	4
01/10/2000 9:03 AM	1261	13th&5th	North	6	5
01/10/2000 9:04 AM	1528	13th&5th	North	6	4
01/10/2000 9:08 AM	1410	13th&5th	North	6	5

Appendix C. Speed Data

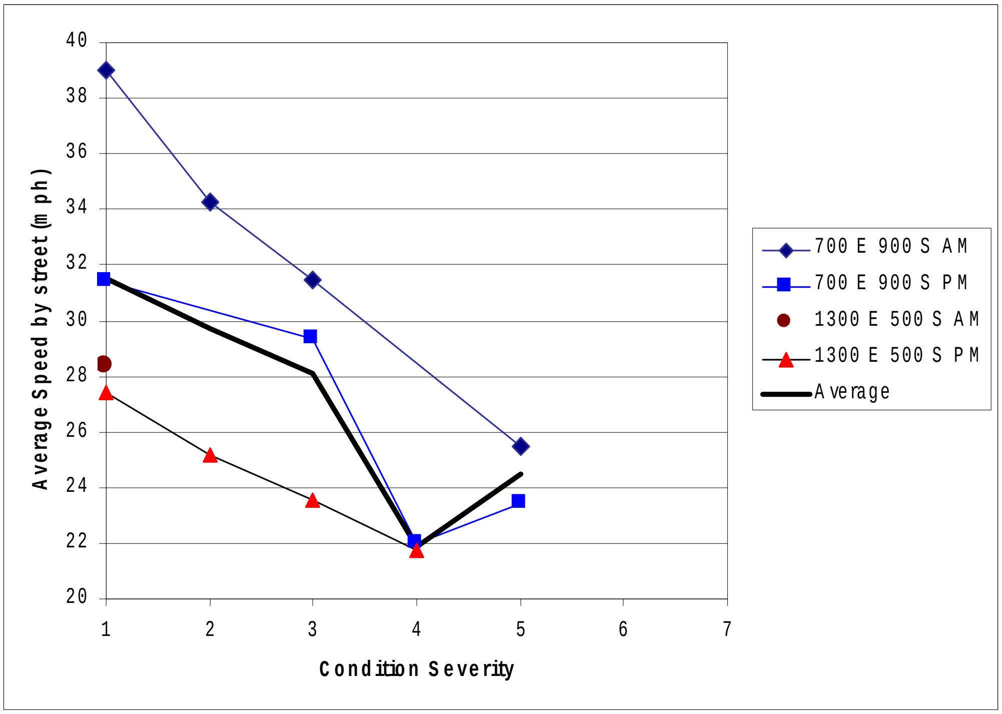

Figure C1 **Average Speeds per street**

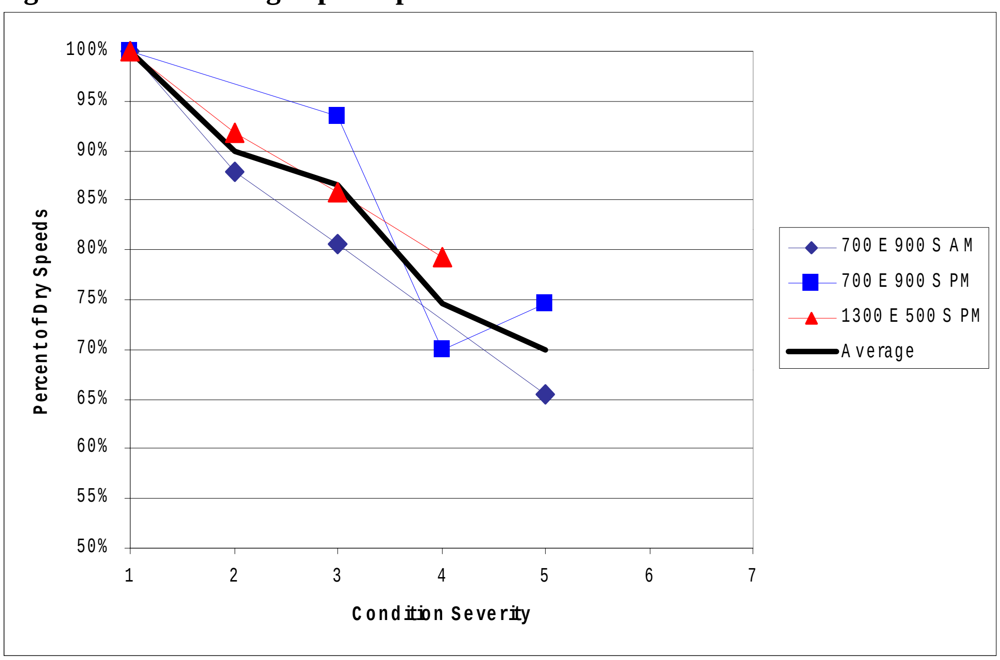

Figure C2 **Percent of dry speeds per weather condition**

Date	Time	Speed	Condition	location	Direction
12/23/1999	7:30 AM	28	1	13th&5th	NB
12/23/1999	7:30 AM	29	1	13th&5th	NB
12/23/1999	7:30 AM	23	1	13th&5th	NB
12/23/1999	7:30 AM	31	1	13th&5th	NB
12/23/1999	7:30 AM	18	1	13th&5th	NB
12/23/1999	7:40 AM	24	1	13th&5th	NB
12/23/1999	7:40 AM	22	1	13th&5th	NB
12/23/1999	7:40 AM	23	1	13th&5th	NB
12/23/1999	7:40 AM	20	1	13th&5th	NB
12/23/1999	7:40 AM	38	1	13th&5th	NB
12/23/1999	7:40 AM	28	1	13th&5th	NB
12/23/1999	7:50 AM	27	1	13th&5th	NB
12/23/1999	7:50 AM	34	1	13th&5th	NB
12/23/1999	7:50 AM	32	1	13th&5th	NB
12/23/1999	7:50 AM	35	1	13th&5th	NB
12/23/1999	7:50 AM	24	1	13th&5th	NB
12/23/1999	7:50 AM	24	1	13th&5th	NB
12/23/1999	7:50 AM	28	1	13th&5th	NB
12/23/1999	7:50 AM	38	1	13th&5th	NB
12/23/1999	8:00 AM	27	1	13th&5th	NB
12/23/1999	8:00 AM	29	1	13th&5th	NB
12/23/1999	8:00 AM	24	1	13th&5th	NB
12/23/1999	8:00 AM	33	1	13th&5th	NB
12/23/1999	8:00 AM	28	1	13th&5th	NB

Key to Road Conditions:

1. Dry
2. Wet
3.Wet and Snowing
4. Wet and Slushy
5. Slushy in Wheel paths
6. Snowy and Sticking
7. Snow Packed

12/23/1999	8:10 AM	32	1	13th&5th	NB
12/23/1999	8:10 AM	27	1	13th&5th	NB
12/23/1999	8:10 AM	17	1	13th&5th	NB
12/23/1999	8:10 AM	25	1	13th&5th	NB
01/12/2000	7:30 AM	30	1	13th&5th	NB
01/12/2000	7:40 AM	31	1	13th&5th	NB
01/12/2000	7:50 AM	40	1	13th&5th	NB
01/12/2000	8:00 AM	40	1	13th&5th	NB
01/12/2000	8:10 AM	36	1	13th&5th	NB
01/12/2000	8:20 AM	34	1	13th&5th	NB
01/12/2000	8:20 AM	36	1	13th&5th	NB
01/12/2000	8:20 AM	41	1	13th&5th	NB
01/12/2000	8:20 AM	34	1	13th&5th	NB
01/12/2000	8:20 AM	40	1	13th&5th	NB
01/12/2000	8:20 AM	38	1	13th&5th	NB
02/17/2000	8:15 AM	26	1	13th&5th	NB
02/17/2000	8:15 AM	32	1	13th&5th	NB
02/17/2000	8:15 AM	20	1	13th&5th	NB
02/17/2000	8:15 AM	23	1	13th&5th	NB
02/17/2000	8:25 AM	22	1	13th&5th	NB
02/17/2000	8:25 AM	33	1	13th&5th	NB
02/17/2000	8:25 AM	38	1	13th&5th	NB
02/17/2000	8:25 AM	20	1	13th&5th	NB
02/17/2000	8:25 AM	25	1	13th&5th	NB
02/17/2000	8:25 AM	35	1	13th&5th	NB

02/17/2000	8:35 AM	28	1	13th&5th	NB
02/17/2000	8:35 AM	19	1	13th&5th	NB
02/17/2000	8:35 AM	36	1	13th&5th	NB
02/17/2000	8:35 AM	26	1	13th&5th	NB
02/17/2000	8:35 AM	24	1	13th&5th	NB
02/17/2000	8:35 AM	25	1	13th&5th	NB
02/17/2000	8:35 AM	30	1	13th&5th	NB
02/17/2000	8:45 AM	20	1	13th&5th	NB
02/17/2000	8:45 AM	26	1	13th&5th	NB
02/17/2000	8:45 AM	30	1	13th&5th	NB
02/17/2000	8:45 AM	21	1	13th&5th	NB
02/17/2000	8:45 AM	24	1	13th&5th	NB
02/17/2000	8:45 AM	22	1	13th&5th	NB
02/17/2000	8:55 AM	26	1	13th&5th	NB
02/17/2000	8:55 AM	22	1	13th&5th	NB
02/17/2000	8:55 AM	23	1	13th&5th	NB
12/15/1999	6:00 PM	25	1	13th&5th	SB
12/15/1999	6:00 PM	26	1	13th&5th	SB
12/15/1999	6:00 PM	27	1	13th&5th	SB
12/15/1999	6:00 PM	27	1	13th&5th	SB
12/15/1999	6:00 PM	28	1	13th&5th	SB
12/15/1999	6:00 PM	28	1	13th&5th	SB
12/15/1999	6:00 PM	28	1	13th&5th	SB
12/15/1999	6:00 PM	29	1	13th&5th	SB
12/15/1999	6:00 PM	29	1	13th&5th	SB

12/15/1999	6:00 PM	30	1	13th&5th	SB
12/15/1999	6:00 PM	30	1	13th&5th	SB
12/15/1999	6:00 PM	31	1	13th&5th	SB
12/15/1999	6:00 PM	31	1	13th&5th	SB
12/15/1999	6:00 PM	31	1	13th&5th	SB
12/15/1999	6:00 PM	33	1	13th&5th	SB
12/15/1999	6:00 PM	34	1	13th&5th	SB
12/15/1999	6:00 PM	34	1	13th&5th	SB
12/15/1999	6:00 PM	35	1	13th&5th	SB
12/15/1999	6:00 PM	35	1	13th&5th	SB
12/15/1999	6:00 PM	38	1	13th&5th	SB
12/20/1999	4:45 PM	27	1	13th&5th	SB
12/20/1999	4:45 PM	26	1	13th&5th	SB
12/20/1999	4:45 PM	26	1	13th&5th	SB
12/20/1999	4:45 PM	32	1	13th&5th	SB
12/20/1999	4:55 PM	21	1	13th&5th	SB
12/20/1999	4:55 PM	23	1	13th&5th	SB
12/20/1999	4:55 PM	35	1	13th&5th	SB
12/20/1999	4:55 PM	28	1	13th&5th	SB
12/20/1999	4:55 PM	24	1	13th&5th	SB
12/20/1999	5:05 PM	29	1	13th&5th	SB
12/20/1999	5:05 PM	36	1	13th&5th	SB
12/20/1999	5:05 PM	23	1	13th&5th	SB
12/20/1999	5:05 PM	25	1	13th&5th	SB
12/20/1999	5:05 PM	21	1	13th&5th	SB

12/20/1999	5:05 PM	23	1	13th&5th	SB
12/20/1999	5:15 PM	19	1	13th&5th	SB
12/20/1999	5:15 PM	20	1	13th&5th	SB
12/20/1999	5:15 PM	23	1	13th&5th	SB
12/20/1999	5:15 PM	37	1	13th&5th	SB
12/20/1999	5:15 PM	42	1	13th&5th	SB
12/20/1999	5:15 PM	23	1	13th&5th	SB
12/20/1999	5:15 PM	23	1	13th&5th	SB
12/20/1999	5:25 PM	18	1	13th&5th	SB
12/20/1999	5:25 PM	18	1	13th&5th	SB
12/20/1999	5:25 PM	23	1	13th&5th	SB
02/10/2000	5:00 PM	20	1	13th&5th	SB
02/10/2000	5:00 PM	21	1	13th&5th	SB
02/10/2000	5:10 PM	19	1	13th&5th	SB
02/10/2000	5:10 PM	25	1	13th&5th	SB
02/10/2000	5:10 PM	23	1	13th&5th	SB
02/10/2000	5:10 PM	41	1	13th&5th	SB
02/10/2000	5:10 PM	30	1	13th&5th	SB
02/10/2000	5:20 PM	20	1	13th&5th	SB
02/10/2000	5:20 PM	31	1	13th&5th	SB
02/10/2000	5:20 PM	27	1	13th&5th	SB
02/10/2000	5:20 PM	28	1	13th&5th	SB
02/10/2000	5:20 PM	22	1	13th&5th	SB
02/10/2000	5:30 PM	22	1	13th&5th	SB
02/10/2000	5:30 PM	36	1	13th&5th	SB

02/10/2000	5:30 PM	19	1	13th&5th	SB
02/10/2000	5:30 PM	24	1	13th&5th	SB
02/10/2000	5:30 PM	17	1	13th&5th	SB
02/10/2000	5:50 PM	26	1	13th&5th	SB
02/10/2000	5:50 PM	30	1	13th&5th	SB
02/10/2000	5:50 PM	28	1	13th&5th	SB
02/10/2000	5:50 PM	22	1	13th&5th	SB
02/10/2000	5:50 PM	24	1	13th&5th	SB
02/10/2000	6:00 PM	35	1	13th&5th	SB
02/10/2000	6:00 PM	28	1	13th&5th	SB
02/10/2000	6:00 PM	26	1	13th&5th	SB
02/10/2000	6:00 PM	24	1	13th&5th	SB
02/10/2000	6:00 PM	35	1	13th&5th	SB
02/10/2000	6:10 PM	36	1	13th&5th	SB
02/10/2000	6:10 PM	33	1	13th&5th	SB
02/10/2000	6:10 PM	34	1	13th&5th	SB
02/10/2000	6:10 PM	27	1	13th&5th	SB
02/10/2000	6:10 PM	26	1	13th&5th	SB
12/22/1999	7:45 AM	43	1	7th&9th	NB
12/22/1999	7:45 AM	41	1	7th&9th	NB
12/22/1999	7:45 AM	41	1	7th&9th	NB
12/22/1999	7:45 AM	45	1	7th&9th	NB
12/22/1999	7:45 AM	38	1	7th&9th	NB
12/22/1999	7:45 AM	32	1	7th&9th	NB
12/22/1999	7:45 AM	42	1	7th&9th	NB

12/22/1999	7:45 AM	32	1	7th&9th	NB
12/22/1999	7:45 AM	46	1	7th&9th	NB
12/22/1999	7:45 AM	44	1	7th&9th	NB
12/22/1999	7:45 AM	39	1	7th&9th	NB
12/22/1999	7:45 AM	36	1	7th&9th	NB
12/22/1999	7:45 AM	39	1	7th&9th	NB
12/22/1999	7:45 AM	48	1	7th&9th	NB
12/22/1999	7:45 AM	36	1	7th&9th	NB
12/22/1999	7:45 AM	36	1	7th&9th	NB
12/22/1999	7:45 AM	23	1	7th&9th	NB
12/22/1999	7:45 AM	22	1	7th&9th	NB
12/22/1999	7:45 AM	32	1	7th&9th	NB
12/22/1999	7:45 AM	35	1	7th&9th	NB
12/22/1999	7:45 AM	36	1	7th&9th	NB
12/22/1999	7:45 AM	37	1	7th&9th	NB
12/22/1999	7:45 AM	38	1	7th&9th	NB
12/22/1999	7:45 AM	42	1	7th&9th	NB
12/22/1999	7:45 AM	46	1	7th&9th	NB
12/22/1999	7:45 AM	41	1	7th&9th	NB
12/22/1999	7:45 AM	39	1	7th&9th	NB
12/22/1999	7:55 AM	38	1	7th&9th	NB
12/22/1999	7:55 AM	42	1	7th&9th	NB
12/22/1999	7:55 AM	40	1	7th&9th	NB
12/22/1999	7:55 AM	39	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB

12/22/1999	7:55 AM	38	1	7th&9th	NB
12/22/1999	7:55 AM	48	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB
12/22/1999	7:55 AM	35	1	7th&9th	NB
12/22/1999	7:55 AM	34	1	7th&9th	NB
12/22/1999	7:55 AM	37	1	7th&9th	NB
12/22/1999	7:55 AM	35	1	7th&9th	NB
12/22/1999	7:55 AM	37	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB
12/22/1999	7:55 AM	37	1	7th&9th	NB
12/22/1999	7:55 AM	35	1	7th&9th	NB
12/22/1999	7:55 AM	42	1	7th&9th	NB
12/22/1999	7:55 AM	40	1	7th&9th	NB
12/22/1999	7:55 AM	42	1	7th&9th	NB
12/22/1999	7:55 AM	48	1	7th&9th	NB
12/22/1999	7:55 AM	45	1	7th&9th	NB
12/22/1999	7:55 AM	37	1	7th&9th	NB
12/22/1999	7:55 AM	42	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB
12/22/1999	7:55 AM	42	1	7th&9th	NB
12/22/1999	7:55 AM	45	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB
12/22/1999	7:55 AM	38	1	7th&9th	NB
12/22/1999	7:55 AM	36	1	7th&9th	NB
12/22/1999	7:55 AM	43	1	7th&9th	NB

12/22/1999	7:55 AM	37	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB
12/22/1999	7:55 AM	50	1	7th&9th	NB
12/22/1999	7:55 AM	42	1	7th&9th	NB
12/22/1999	7:55 AM	41	1	7th&9th	NB
12/22/1999	7:55 AM	38	1	7th&9th	NB
12/22/1999	7:55 AM	35	1	7th&9th	NB
12/22/1999	7:55 AM	34	1	7th&9th	NB
12/22/1999	7:55 AM	49	1	7th&9th	NB
12/22/1999	7:55 AM	40	1	7th&9th	NB
12/22/1999	7:55 AM	35	1	7th&9th	NB
12/22/1999	7:55 AM	45	1	7th&9th	NB
12/22/1999	8:05 AM	35	1	7th&9th	NB
12/22/1999	8:05 AM	36	1	7th&9th	NB
12/22/1999	8:05 AM	37	1	7th&9th	NB
12/22/1999	8:05 AM	35	1	7th&9th	NB
12/22/1999	8:05 AM	34	1	7th&9th	NB
12/22/1999	8:05 AM	37	1	7th&9th	NB
12/22/1999	8:05 AM	37	1	7th&9th	NB
12/22/1999	8:05 AM	36	1	7th&9th	NB
12/22/1999	8:05 AM	38	1	7th&9th	NB
12/22/1999	8:05 AM	41	1	7th&9th	NB
12/22/1999	8:05 AM	40	1	7th&9th	NB
12/22/1999	8:05 AM	35	1	7th&9th	NB
12/22/1999	8:05 AM	39	1	7th&9th	NB

12/22/1999	8:05 AM	38	1	7th&9th	NB
12/22/1999	8:05 AM	36	1	7th&9th	NB
12/22/1999	8:05 AM	45	1	7th&9th	NB
12/22/1999	8:05 AM	41	1	7th&9th	NB
12/22/1999	8:05 AM	31	1	7th&9th	NB
12/22/1999	8:05 AM	39	1	7th&9th	NB
12/22/1999	8:05 AM	43	1	7th&9th	NB
12/22/1999	8:05 AM	34	1	7th&9th	NB
12/22/1999	8:05 AM	36	1	7th&9th	NB
12/22/1999	8:05 AM	39	1	7th&9th	NB
12/22/1999	8:05 AM	35	1	7th&9th	NB
12/22/1999	8:05 AM	40	1	7th&9th	NB
12/22/1999	8:15 AM	37	1	7th&9th	NB
12/22/1999	8:15 AM	39	1	7th&9th	NB
12/22/1999	8:15 AM	42	1	7th&9th	NB
12/22/1999	8:15 AM	44	1	7th&9th	NB
12/22/1999	8:15 AM	39	1	7th&9th	NB
12/22/1999	8:15 AM	52	1	7th&9th	NB
12/22/1999	8:15 AM	42	1	7th&9th	NB
12/22/1999	8:15 AM	51	1	7th&9th	NB
12/22/1999	8:15 AM	46	1	7th&9th	NB
12/22/1999	8:15 AM	49	1	7th&9th	NB
12/22/1999	8:15 AM	38	1	7th&9th	NB
12/22/1999	8:15 AM	41	1	7th&9th	NB
12/22/1999	8:15 AM	45	1	7th&9th	NB

12/22/1999	8:15 AM	43	1	7th&9th	NB
12/22/1999	8:15 AM	37	1	7th&9th	NB
12/22/1999	8:15 AM	49	1	7th&9th	NB
12/22/1999	8:15 AM	45	1	7th&9th	NB
12/22/1999	8:15 AM	39	1	7th&9th	NB
12/22/1999	8:15 AM	49	1	7th&9th	NB
12/22/1999	8:15 AM	48	1	7th&9th	NB
12/22/1999	8:15 AM	50	1	7th&9th	NB
12/22/1999	8:15 AM	42	1	7th&9th	NB
12/22/1999	8:15 AM	42	1	7th&9th	NB
12/22/1999	8:15 AM	44	1	7th&9th	NB
12/22/1999	8:15 AM	42	1	7th&9th	NB
12/22/1999	8:15 AM	41	1	7th&9th	NB
12/22/1999	8:15 AM	43	1	7th&9th	NB
12/22/1999	8:25 AM	40	1	7th&9th	NB
12/22/1999	8:25 AM	41	1	7th&9th	NB
12/22/1999	8:25 AM	50	1	7th&9th	NB
12/22/1999	8:25 AM	41	1	7th&9th	NB
12/22/1999	8:25 AM	40	1	7th&9th	NB
12/22/1999	8:25 AM	39	1	7th&9th	NB
12/22/1999	8:25 AM	41	1	7th&9th	NB
12/22/1999	8:25 AM	38	1	7th&9th	NB
12/22/1999	8:25 AM	40	1	7th&9th	NB
12/22/1999	8:25 AM	46	1	7th&9th	NB
12/22/1999	8:25 AM	39	1	7th&9th	NB

12/22/1999	8:25 AM	37	1	7th&9th	NB
12/22/1999	8:25 AM	50	1	7th&9th	NB
12/22/1999	8:25 AM	43	1	7th&9th	NB
12/22/1999	8:25 AM	38	1	7th&9th	NB
12/22/1999	8:25 AM	49	1	7th&9th	NB
12/22/1999	8:25 AM	45	1	7th&9th	NB
12/22/1999	8:25 AM	37	1	7th&9th	NB
12/22/1999	8:25 AM	38	1	7th&9th	NB
12/22/1999	8:25 AM	42	1	7th&9th	NB
12/22/1999	8:25 AM	39	1	7th&9th	NB
12/15/1999	5:30 PM	22	1	7th&9th	SB
12/15/1999	5:30 PM	22	1	7th&9th	SB
12/15/1999	5:30 PM	24	1	7th&9th	SB
12/15/1999	5:30 PM	25	1	7th&9th	SB
12/15/1999	5:30 PM	25	1	7th&9th	SB
12/15/1999	5:30 PM	25	1	7th&9th	SB
12/15/1999	5:30 PM	26	1	7th&9th	SB
12/15/1999	5:30 PM	27	1	7th&9th	SB
12/15/1999	5:30 PM	27	1	7th&9th	SB
12/15/1999	5:30 PM	28	1	7th&9th	SB
12/15/1999	5:30 PM	28	1	7th&9th	SB
12/15/1999	5:30 PM	28	1	7th&9th	SB
12/15/1999	5:30 PM	29	1	7th&9th	SB
12/15/1999	5:30 PM	29	1	7th&9th	SB
12/15/1999	5:30 PM	30	1	7th&9th	SB

12/15/1999	5:30 PM	30	1	7th&9th	SB
12/15/1999	5:30 PM	30	1	7th&9th	SB
12/15/1999	5:30 PM	31	1	7th&9th	SB
12/15/1999	5:30 PM	31	1	7th&9th	SB
12/15/1999	5:30 PM	32	1	7th&9th	SB
12/15/1999	5:30 PM	35	1	7th&9th	SB
12/15/1999	5:30 PM	37	1	7th&9th	SB
12/15/1999	5:30 PM	38	1	7th&9th	SB
12/15/1999	5:30 PM	38	1	7th&9th	SB
12/15/1999	5:30 PM	38	1	7th&9th	SB
12/15/1999	5:30 PM	38	1	7th&9th	SB
12/15/1999	5:30 PM	40	1	7th&9th	SB
12/15/1999	5:30 PM	40	1	7th&9th	SB
12/15/1999	5:30 PM	41	1	7th&9th	SB
12/15/1999	5:30 PM	41	1	7th&9th	SB
12/15/1999	5:30 PM	21	1	7th&9th	SB
12/15/1999	5:30 PM	23	1	7th&9th	SB
12/15/1999	5:30 PM	23	1	7th&9th	SB
12/15/1999	5:30 PM	24	1	7th&9th	SB
12/15/1999	5:30 PM	25	1	7th&9th	SB
12/15/1999	5:30 PM	26	1	7th&9th	SB
12/15/1999	5:30 PM	27	1	7th&9th	SB
12/15/1999	5:30 PM	27	1	7th&9th	SB
12/15/1999	5:30 PM	27	1	7th&9th	SB
12/15/1999	5:30 PM	28	1	7th&9th	SB

12/15/1999	5:30 PM	28	1	7th&9th	SB
12/15/1999	5:30 PM	28	1	7th&9th	SB
12/15/1999	5:30 PM	30	1	7th&9th	SB
12/15/1999	5:30 PM	31	1	7th&9th	SB
12/15/1999	5:30 PM	32	1	7th&9th	SB
12/15/1999	5:30 PM	34	1	7th&9th	SB
12/15/1999	5:30 PM	36	1	7th&9th	SB
12/15/1999	5:30 PM	36	1	7th&9th	SB
12/15/1999	5:30 PM	36	1	7th&9th	SB
12/15/1999	5:30 PM	36	1	7th&9th	SB
12/15/1999	5:30 PM	37	1	7th&9th	SB
12/15/1999	5:30 PM	38	1	7th&9th	SB
12/15/1999	5:30 PM	39	1	7th&9th	SB
12/15/1999	5:30 PM	39	1	7th&9th	SB
12/15/1999	5:30 PM	39	1	7th&9th	SB
12/15/1999	5:30 PM	40	1	7th&9th	SB
12/15/1999	5:30 PM	40	1	7th&9th	SB
12/15/1999	5:30 PM	41	1	7th&9th	SB
12/15/1999	5:30 PM	42	1	7th&9th	SB
12/15/1999	5:30 PM	41	1	7th&9th	SB
12/20/1999	5:00 PM	28	1	7th&9th	SB
12/20/1999	5:00 PM	32	1	7th&9th	SB
12/20/1999	5:00 PM	28	1	7th&9th	SB
12/20/1999	5:00 PM	33	1	7th&9th	SB
12/20/1999	5:00 PM	29	1	7th&9th	SB

12/20/1999	5:00 PM	28	1	7th&9th	SB
12/20/1999	5:00 PM	30	1	7th&9th	SB
12/20/1999	5:00 PM	31	1	7th&9th	SB
12/20/1999	5:00 PM	38	1	7th&9th	SB
12/20/1999	5:00 PM	35	1	7th&9th	SB
12/20/1999	5:10 PM	27	1	7th&9th	SB
12/20/1999	5:10 PM	28	1	7th&9th	SB
12/20/1999	5:10 PM	30	1	7th&9th	SB
12/20/1999	5:10 PM	31	1	7th&9th	SB
12/20/1999	5:10 PM	39	1	7th&9th	SB
12/20/1999	5:10 PM	25	1	7th&9th	SB
12/20/1999	5:10 PM	30	1	7th&9th	SB
12/20/1999	5:20 PM	29	1	7th&9th	SB
12/20/1999	5:20 PM	29	1	7th&9th	SB
12/20/1999	5:20 PM	24	1	7th&9th	SB
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12/20/1999	5:20 PM	27	1	7th&9th	SB
12/20/1999	5:20 PM	28	1	7th&9th	SB
12/20/1999	5:20 PM	35	1	7th&9th	SB
12/20/1999	5:20 PM	29	1	7th&9th	SB
12/20/1999	5:20 PM	43	1	7th&9th	SB

12/20/1999	5:20 PM	37	1	7th&9th	SB
12/20/1999	5:20 PM	41	1	7th&9th	SB
12/20/1999	5:20 PM	39	1	7th&9th	SB
12/20/1999	5:20 PM	37	1	7th&9th	SB
12/20/1999	5:20 PM	38	1	7th&9th	SB
12/20/1999	5:20 PM	30	1	7th&9th	SB
12/20/1999	5:20 PM	35	1	7th&9th	SB
12/20/1999	5:20 PM	32	1	7th&9th	SB
12/20/1999	5:20 PM	27	1	7th&9th	SB
12/20/1999	5:20 PM	40	1	7th&9th	SB
12/20/1999	5:20 PM	38	1	7th&9th	SB
12/20/1999	5:20 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	39	1	7th&9th	SB
12/20/1999	5:30 PM	32	1	7th&9th	SB
12/20/1999	5:30 PM	36	1	7th&9th	SB
12/20/1999	5:30 PM	37	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	28	1	7th&9th	SB
12/20/1999	5:30 PM	27	1	7th&9th	SB
12/20/1999	5:30 PM	27	1	7th&9th	SB
12/20/1999	5:30 PM	35	1	7th&9th	SB
12/20/1999	5:30 PM	35	1	7th&9th	SB
12/20/1999	5:30 PM	31	1	7th&9th	SB
12/20/1999	5:30 PM	31	1	7th&9th	SB

12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	37	1	7th&9th	SB
12/20/1999	5:30 PM	36	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	37	1	7th&9th	SB
12/20/1999	5:30 PM	36	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	28	1	7th&9th	SB
12/20/1999	5:30 PM	29	1	7th&9th	SB
12/20/1999	5:30 PM	42	1	7th&9th	SB
12/20/1999	5:30 PM	36	1	7th&9th	SB
12/20/1999	5:30 PM	34	1	7th&9th	SB
06/19/2000	9:13 AM	36	2	7th&9th	NB
06/19/2000	9:13 AM	37	2	7th&9th	NB
06/19/2000	9:13 AM	39	2	7th&9th	NB
06/19/2000	9:15 AM	35	2	7th&9th	NB
06/19/2000	9:15 AM	36	2	7th&9th	NB
06/19/2000	9:15 AM	40	2	7th&9th	NB
06/19/2000	9:17 AM	34	2	7th&9th	NB
06/19/2000	9:17 AM	44	2	7th&9th	NB
06/19/2000	9:17 AM	37	2	7th&9th	NB
06/19/2000	9:18 AM	31	2	7th&9th	NB
06/19/2000	9:18 AM	37	2	7th&9th	NB

06/19/2000	9:18 AM	32	2	7th&9th	NB
06/19/2000	9:20 AM	29	2	7th&9th	NB
06/19/2000	9:20 AM	37	2	7th&9th	NB
06/19/2000	9:20 AM	28	2	7th&9th	NB
06/19/2000	9:22 AM	35	2	7th&9th	NB
06/19/2000	9:22 AM	36	2	7th&9th	NB
06/19/2000	9:22 AM	37	2	7th&9th	NB
06/19/2000	9:24 AM	32	2	7th&9th	NB
06/19/2000	9:24 AM	31	2	7th&9th	NB
06/19/2000	9:24 AM	33	2	7th&9th	NB
06/19/2000	9:26 AM	35	2	7th&9th	NB
06/19/2000	9:26 AM	33	2	7th&9th	NB
06/19/2000	9:26 AM	32	2	7th&9th	NB
06/19/2000	9:27 AM	30	2	7th&9th	NB
06/19/2000	9:27 AM	35	2	7th&9th	NB
06/19/2000	9:27 AM	36	2	7th&9th	NB
06/19/2000	9:28 AM	35	2	7th&9th	NB
06/19/2000	9:28 AM	23	2	7th&9th	NB
06/19/2000	9:28 AM	27	2	7th&9th	NB
06/19/2000	9:29 AM	37	2	7th&9th	NB
06/19/2000	9:29 AM	38	2	7th&9th	NB
06/19/2000	9:29 AM	32	2	7th&9th	NB
06/19/2000	9:30 AM	36	2	7th&9th	NB
06/19/2000	9:30 AM	35	2	7th&9th	NB
06/19/2000	9:30 AM	31	2	7th&9th	NB

06/19/2000	9:31 AM	34	2	7th&9th	NB
06/19/2000	9:31 AM	32	2	7th&9th	NB
06/19/2000	9:31 AM	34	2	7th&9th	NB
06/19/2000	9:32 AM	34	2	7th&9th	NB
06/19/2000	9:32 AM	32	2	7th&9th	NB
06/19/2000	9:32 AM	31	2	7th&9th	NB
06/19/2000	9:33 AM	37	2	7th&9th	NB
06/19/2000	9:33 AM	36	2	7th&9th	NB
06/19/2000	9:33 AM	33	2	7th&9th	NB
06/19/2000	9:34 AM	33	2	7th&9th	NB
06/19/2000	9:34 AM	26	2	7th&9th	NB
06/19/2000	9:34 AM	29	2	7th&9th	NB
06/19/2000	9:35 AM	34	2	7th&9th	NB
06/19/2000	9:35 AM	31	2	7th&9th	NB
06/19/2000	9:35 AM	29	2	7th&9th	NB
06/19/2000	9:36 AM	36	2	7th&9th	NB
06/19/2000	9:36 AM	44	2	7th&9th	NB
06/19/2000	9:36 AM	37	2	7th&9th	NB
06/19/2000	9:37 AM	34	2	7th&9th	NB
06/19/2000	9:37 AM	32	2	7th&9th	NB
06/19/2000	9:37 AM	27	2	7th&9th	NB
06/19/2000	9:38 AM	42	2	7th&9th	NB
06/19/2000	9:38 AM	36	2	7th&9th	NB
06/19/2000	9:38 AM	36	2	7th&9th	NB
06/19/2000	9:39 AM	38	2	7th&9th	NB

06/19/2000	9:39 AM	36	2	7th&9th	NB
06/19/2000	9:39 AM	37	2	7th&9th	NB
06/19/2000	9:40 AM	37	2	7th&9th	NB
06/19/2000	9:40 AM	36	2	7th&9th	NB
06/19/2000	9:40 AM	30	2	7th&9th	NB
06/19/2000	9:41 AM	31	2	7th&9th	NB
06/19/2000	9:41 AM	35	2	7th&9th	NB
06/19/2000	9:41 AM	33	2	7th&9th	NB
06/19/2000	9:44 AM	36	2	7th&9th	NB
06/19/2000	9:44 AM	32	2	7th&9th	NB
06/19/2000	9:44 AM	33	2	7th&9th	NB
06/19/2000	9:45 AM	33	2	7th&9th	NB
06/19/2000	9:45 AM	36	2	7th&9th	NB
06/19/2000	9:45 AM	34	2	7th&9th	NB
06/19/2000	9:47 AM	26	2	7th&9th	NB
06/19/2000	9:47 AM	28	2	7th&9th	NB
06/19/2000	9:47 AM	33	2	7th&9th	NB
06/19/2000	9:48 AM	39	2	7th&9th	NB
06/19/2000	9:48 AM	35	2	7th&9th	NB
06/19/2000	9:48 AM	31	2	7th&9th	NB
06/19/2000	9:49 AM	39	2	7th&9th	NB
06/19/2000	9:49 AM	36	2	7th&9th	NB
06/19/2000	9:49 AM	33	2	7th&9th	NB
06/19/2000	9:51 AM	36	2	7th&9th	NB
06/19/2000	9:51 AM	34	2	7th&9th	NB

06/19/2000	9:51 AM	32	2	7th&9th	NB
06/19/2000	9:52 AM	48	2	7th&9th	NB
06/19/2000	9:52 AM	43	2	7th&9th	NB
06/19/2000	9:52 AM	45	2	7th&9th	NB
06/19/2000	9:53 AM	36	2	7th&9th	NB
06/19/2000	9:53 AM	44	2	7th&9th	NB
06/19/2000	9:53 AM	39	2	7th&9th	NB
06/19/2000	9:54 AM	31	2	7th&9th	NB
06/19/2000	9:54 AM	34	2	7th&9th	NB
06/19/2000	9:54 AM	33	2	7th&9th	NB
06/19/2000	9:56 AM	38	2	7th&9th	NB
06/19/2000	9:56 AM	36	2	7th&9th	NB
06/19/2000	9:56 AM	34	2	7th&9th	NB
06/19/2000	9:58 AM	39	2	7th&9th	NB
06/19/2000	9:58 AM	35	2	7th&9th	NB
06/19/2000	9:58 AM	34	2	7th&9th	NB
06/19/2000	9:59 AM	36	2	7th&9th	NB
06/19/2000	9:59 AM	35	2	7th&9th	NB
06/19/2000	9:59 AM	32	2	7th&9th	NB
06/19/2000	10:00 AM	36	2	7th&9th	NB
06/19/2000	10:00 AM	32	2	7th&9th	NB
06/19/2000	10:00 AM	33	2	7th&9th	NB
06/19/2000	10:02 AM	34	2	7th&9th	NB
06/19/2000	10:02 AM	31	2	7th&9th	NB
06/19/2000	10:02 AM	37	2	7th&9th	NB

05/08/2000	10:45 AM	23	2	13th&5th	SB
05/08/2000	10:45 AM	22	2	13th&5th	SB
05/08/2000	10:45 AM	21	2	13th&5th	SB
05/08/2000	10:47 AM	21	2	13th&5th	SB
05/08/2000	10:47 AM	23	2	13th&5th	SB
05/08/2000	10:47 AM	20	2	13th&5th	SB
05/08/2000	10:49 AM	19	2	13th&5th	SB
05/08/2000	10:49 AM	22	2	13th&5th	SB
05/08/2000	10:49 AM	24	2	13th&5th	SB
05/08/2000	10:51 AM	25	2	13th&5th	SB
05/08/2000	10:51 AM	24	2	13th&5th	SB
05/08/2000	10:51 AM	24	2	13th&5th	SB
05/08/2000	10:53 AM	25	2	13th&5th	SB
05/08/2000	10:53 AM	22	2	13th&5th	SB
05/08/2000	10:53 AM	22	2	13th&5th	SB
05/08/2000	10:54 AM	21	2	13th&5th	SB
05/08/2000	10:54 AM	21	2	13th&5th	SB
05/08/2000	10:54 AM	24	2	13th&5th	SB
05/08/2000	10:56 AM	25	2	13th&5th	SB
05/08/2000	10:56 AM	24	2	13th&5th	SB
05/08/2000	10:56 AM	24	2	13th&5th	SB
05/08/2000	10:58 AM	26	2	13th&5th	SB
05/08/2000	10:58 AM	25	2	13th&5th	SB
05/08/2000	10:58 AM	25	2	13th&5th	SB
05/08/2000	11:00 AM	24	2	13th&5th	SB

05/08/2000	11:00 AM	25	2	13th&5th	SB
05/08/2000	11:00 AM	23	2	13th&5th	SB
05/08/2000	11:02 AM	26	2	13th&5th	SB
05/08/2000	11:02 AM	23	2	13th&5th	SB
05/08/2000	11:02 AM	24	2	13th&5th	SB
05/08/2000	11:04 AM	25	2	13th&5th	SB
05/08/2000	11:04 AM	26	2	13th&5th	SB
05/08/2000	11:04 AM	23	2	13th&5th	SB
05/08/2000	11:06 AM	27	2	13th&5th	SB
05/08/2000	11:06 AM	25	2	13th&5th	SB
05/08/2000	11:06 AM	26	2	13th&5th	SB
05/08/2000	11:08 AM	25	2	13th&5th	SB
05/08/2000	11:08 AM	24	2	13th&5th	SB
05/08/2000	11:08 AM	26	2	13th&5th	SB
05/08/2000	11:10 AM	28	2	13th&5th	SB
05/08/2000	11:10 AM	27	2	13th&5th	SB
05/08/2000	11:10 AM	27	2	13th&5th	SB
05/08/2000	11:11 AM	26	2	13th&5th	SB
05/08/2000	11:11 AM	26	2	13th&5th	SB
05/08/2000	11:11 AM	25	2	13th&5th	SB
05/08/2000	11:13 AM	25	2	13th&5th	SB
05/08/2000	11:13 AM	27	2	13th&5th	SB
05/08/2000	11:13 AM	28	2	13th&5th	SB
05/08/2000	11:15 AM	24	2	13th&5th	SB
05/08/2000	11:15 AM	26	2	13th&5th	SB

05/08/2000	11:15 AM	29	2	13th&5th	SB	
05/08/2000	11:17 AM	26	2	13th&5th	SB	
05/08/2000	11:17 AM	28	2	13th&5th	SB	
05/08/2000	11:17 AM	29	2	13th&5th	SB	
05/08/2000	11:19 AM	27	2	13th&5th	SB	
05/08/2000	11:19 AM	27	2	13th&5th	SB	
05/08/2000	11:19 AM	24	2	13th&5th	SB	
05/08/2000	11:21 AM	28	2	13th&5th	SB	
05/08/2000	11:21 AM	29	2	13th&5th	SB	
05/08/2000	11:21 AM	30	2	13th&5th	SB	
05/08/2000	11:23 AM	28	2	13th&5th	SB	
05/08/2000	11:23 AM	27	2	13th&5th	SB	
05/08/2000	11:23 AM	28	2	13th&5th	SB	
05/08/2000	11:25 AM	28	2	13th&5th	SB	
05/08/2000	11:25 AM	26	2	13th&5th	SB	
05/08/2000	11:25 AM	25	2	13th&5th	SB	
05/08/2000	11:27 AM	28	2	13th&5th	SB	
05/08/2000	11:27 AM	29	2	13th&5th	SB	
05/08/2000	11:27 AM	30	2	13th&5th	SB	
02/17/2000	4:15 PM	20	3	13th&5th	SB	118.3333333
02/17/2000	4:15 PM	36	3	13th&5th	SB	
02/17/2000	4:15 PM	20	3	13th&5th	SB	
02/17/2000	4:15 PM	23	3	13th&5th	SB	60
02/17/2000	4:15 PM	23	3	13th&5th	SB	
02/17/2000	4:15 PM	34	3	13th&5th	SB	

02/17/2000	4:15 PM	21	3	13th&5th	SB
02/17/2000	4:15 PM	22	3	13th&5th	SB
02/17/2000	4:15 PM	20	3	13th&5th	SB
02/17/2000	4:15 PM	22	3	13th&5th	SB
02/17/2000	4:15 PM	23	3	13th&5th	SB
02/17/2000	4:15 PM	25	3	13th&5th	SB
02/17/2000	4:25 PM	20	3	13th&5th	SB
02/17/2000	4:25 PM	36	3	13th&5th	SB
02/17/2000	4:25 PM	22	3	13th&5th	SB
02/17/2000	4:25 PM	21	3	13th&5th	SB
02/17/2000	4:25 PM	22	3	13th&5th	SB
02/17/2000	4:25 PM	23	3	13th&5th	SB
02/17/2000	4:25 PM	24	3	13th&5th	SB
02/17/2000	4:25 PM	27	3	13th&5th	SB
02/17/2000	4:25 PM	23	3	13th&5th	SB
02/17/2000	4:25 PM	26	3	13th&5th	SB
02/17/2000	4:25 PM	25	3	13th&5th	SB
02/17/2000	4:25 PM	30	3	13th&5th	SB
02/17/2000	4:35 PM	35	3	13th&5th	SB
02/17/2000	4:35 PM	35	3	13th&5th	SB
02/17/2000	4:35 PM	17	3	13th&5th	SB
02/17/2000	4:35 PM	23	3	13th&5th	SB
02/17/2000	4:35 PM	29	3	13th&5th	SB
02/17/2000	4:35 PM	11	3	13th&5th	SB
02/17/2000	4:35 PM	23	3	13th&5th	SB

02/17/2000	4:35 PM	26	3	13th&5th	SB
02/17/2000	4:35 PM	20	3	13th&5th	SB
02/17/2000	4:35 PM	21	3	13th&5th	SB
02/17/2000	4:35 PM	28	3	13th&5th	SB
02/17/2000	4:35 PM	21	3	13th&5th	SB
02/17/2000	4:35 PM	23	3	13th&5th	SB
02/17/2000	4:35 PM	24	3	13th&5th	SB
02/17/2000	4:45 PM	29	3	13th&5th	SB
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02/17/2000	4:45 PM	19	3	13th&5th	SB
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02/17/2000	4:55 PM	23	3	13th&5th	SB
02/17/2000	4:55 PM	14	3	13th&5th	SB
02/17/2000	4:55 PM	17	3	13th&5th	SB
02/17/2000	4:55 PM	19	3	13th&5th	SB

02/17/2000	4:55 PM	19	3	13th&5th	SB
02/17/2000	4:55 PM	21	3	13th&5th	SB
02/17/2000	4:55 PM	24	3	13th&5th	SB
02/17/2000	4:55 PM	21	3	13th&5th	SB
02/17/2000	4:55 PM	17	3	13th&5th	SB
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02/17/2000	5:05 PM	21	3	13th&5th	SB
02/17/2000	5:05 PM	23	3	13th&5th	SB
02/17/2000	5:05 PM	20	3	13th&5th	SB
02/17/2000	5:05 PM	21	3	13th&5th	SB
02/17/2000	5:05 PM	25	3	13th&5th	SB
02/17/2000	5:05 PM	21	3	13th&5th	SB
02/17/2000	5:05 PM	26	3	13th&5th	SB
02/17/2000	5:05 PM	24	3	13th&5th	SB
02/17/2000	5:05 PM	19	3	13th&5th	SB
02/17/2000	5:05 PM	17	3	13th&5th	SB
02/17/2000	5:05 PM	23	3	13th&5th	SB
02/17/2000	5:05 PM	29	3	13th&5th	SB
02/17/2000	5:05 PM	22	3	13th&5th	SB
02/17/2000	5:05 PM	21	3	13th&5th	SB
02/17/2000	5:15 PM	22	3	13th&5th	SB
02/17/2000	5:15 PM	28	3	13th&5th	SB
02/17/2000	5:15 PM	20	3	13th&5th	SB

02/17/2000	5:15 PM	22	3	13th&5th	SB
02/17/2000	5:15 PM	30	3	13th&5th	SB
02/17/2000	5:15 PM	22	3	13th&5th	SB
02/17/2000	5:15 PM	24	3	13th&5th	SB
02/17/2000	5:15 PM	23	3	13th&5th	SB
02/17/2000	5:15 PM	27	3	13th&5th	SB
02/17/2000	5:15 PM	32	3	13th&5th	SB
02/17/2000	5:25 PM	21	3	13th&5th	SB
02/17/2000	5:25 PM	23	3	13th&5th	SB
02/17/2000	5:25 PM	33	3	13th&5th	SB
02/17/2000	5:25 PM	25	3	13th&5th	SB
02/17/2000	5:25 PM	23	3	13th&5th	SB
02/17/2000	5:25 PM	25	3	13th&5th	SB
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02/17/2000	5:25 PM	29	3	13th&5th	SB
02/17/2000	5:25 PM	22	3	13th&5th	SB
02/17/2000	5:25 PM	24	3	13th&5th	SB
02/24/2000	1:00 PM	19	3	13th&5th	SB
02/24/2000	1:00 PM	22	3	13th&5th	SB
02/24/2000	1:00 PM	18	3	13th&5th	SB
02/24/2000	1:10 PM	21	3	13th&5th	SB
02/24/2000	1:10 PM	19	3	13th&5th	SB
02/24/2000	1:10 PM	18	3	13th&5th	SB
02/24/2000	1:10 PM	19	3	13th&5th	SB
02/24/2000	1:10 PM	21	3	13th&5th	SB

02/24/2000	1:10 PM	18	3	13th&5th	SB
02/24/2000	1:10 PM	24	3	13th&5th	SB
02/24/2000	1:10 PM	26	3	13th&5th	SB
02/24/2000	1:10 PM	22	3	13th&5th	SB
02/24/2000	1:10 PM	27	3	13th&5th	SB
02/24/2000	1:10 PM	23	3	13th&5th	SB
02/24/2000	1:10 PM	25	3	13th&5th	SB
02/24/2000	1:20 PM	20	3	13th&5th	SB
02/24/2000	1:20 PM	26	3	13th&5th	SB
02/24/2000	1:20 PM	23	3	13th&5th	SB
01/10/2000	8:25 AM	26	3	7th&9th	NB
01/10/2000	8:25 AM	32	3	7th&9th	NB
01/10/2000	8:25 AM	28	3	7th&9th	NB
01/10/2000	8:25 AM	32	3	7th&9th	NB
01/10/2000	8:25 AM	30	3	7th&9th	NB
01/10/2000	8:25 AM	27	3	7th&9th	NB
01/10/2000	8:25 AM	26	3	7th&9th	NB
01/10/2000	8:25 AM	28	3	7th&9th	NB
01/10/2000	8:25 AM	36	3	7th&9th	NB
01/10/2000	8:25 AM	35	3	7th&9th	NB
01/10/2000	8:25 AM	31	3	7th&9th	NB
01/10/2000	8:25 AM	20	3	7th&9th	NB
01/10/2000	8:35 AM	35	3	7th&9th	NB
01/10/2000	8:35 AM	38	3	7th&9th	NB
01/10/2000	8:35 AM	36	3	7th&9th	NB

01/10/2000	8:35 AM	29	3	7th&9th	NB
01/10/2000	8:35 AM	38	3	7th&9th	NB
01/10/2000	8:35 AM	39	3	7th&9th	NB
01/10/2000	8:35 AM	28	3	7th&9th	NB
01/10/2000	8:35 AM	22	3	7th&9th	NB
01/10/2000	8:35 AM	38	3	7th&9th	NB
01/10/2000	8:35 AM	20	3	7th&9th	NB
01/10/2000	8:35 AM	28	3	7th&9th	NB
01/10/2000	8:45 AM	25	3	7th&9th	NB
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01/10/2000	8:55 AM	31	3	7th&9th	NB
01/10/2000	8:55 AM	33	3	7th&9th	NB
01/10/2000	8:55 AM	28	3	7th&9th	NB
01/10/2000	8:55 AM	26	3	7th&9th	NB

01/10/2000	8:55 AM	31	3	7th&9th	NB
01/10/2000	8:55 AM	33	3	7th&9th	NB
01/10/2000	8:55 AM	28	3	7th&9th	NB
01/10/2000	8:55 AM	33	3	7th&9th	NB
01/10/2000	8:55 AM	27	3	7th&9th	NB
01/10/2000	8:55 AM	28	3	7th&9th	NB
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01/10/2000	9:05 AM	31	3	7th&9th	NB
01/10/2000	9:05 AM	33	3	7th&9th	NB
01/10/2000	9:05 AM	36	3	7th&9th	NB
01/10/2000	9:05 AM	37	3	7th&9th	NB
01/10/2000	9:05 AM	29	3	7th&9th	NB
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01/10/2000	9:05 AM	28	3	7th&9th	NB
01/10/2000	9:05 AM	33	3	7th&9th	NB
01/10/2000	9:05 AM	31	3	7th&9th	NB
01/10/2000	9:05 AM	36	3	7th&9th	NB
01/10/2000	9:15 AM	38	3	7th&9th	NB
01/10/2000	9:15 AM	35	3	7th&9th	NB
01/10/2000	9:15 AM	29	3	7th&9th	NB

01/10/2000	9:15 AM	30	3	7th&9th	NB
01/10/2000	9:15 AM	27	3	7th&9th	NB
01/10/2000	9:15 AM	28	3	7th&9th	NB
01/10/2000	9:15 AM	39	3	7th&9th	NB
01/10/2000	9:15 AM	40	3	7th&9th	NB
01/10/2000	9:15 AM	39	3	7th&9th	NB
01/10/2000	9:15 AM	36	3	7th&9th	NB
01/10/2000	9:15 AM	35	3	7th&9th	NB
01/10/2000	9:15 AM	37	3	7th&9th	NB
01/10/2000	9:15 AM	39	3	7th&9th	NB
01/10/2000	9:15 AM	37	3	7th&9th	NB
01/10/2000	9:15 AM	36	3	7th&9th	NB
01/10/2000	9:15 AM	39	3	7th&9th	NB
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02/17/2000	3:45 PM	34	3	7th&9th	SB
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02/17/2000	3:45 PM	35	3	7th&9th	SB
02/17/2000	3:45 PM	32	3	7th&9th	SB
02/17/2000	3:45 PM	24	3	7th&9th	SB
02/17/2000	3:45 PM	29	3	7th&9th	SB
02/17/2000	3:45 PM	25	3	7th&9th	SB
02/17/2000	3:45 PM	35	3	7th&9th	SB

02/17/2000	3:45 PM	36	3	7th&9th	SB
02/17/2000	3:45 PM	30	3	7th&9th	SB
02/17/2000	3:45 PM	31	3	7th&9th	SB
02/17/2000	3:45 PM	26	3	7th&9th	SB
02/17/2000	3:45 PM	28	3	7th&9th	SB
02/17/2000	3:45 PM	28	3	7th&9th	SB
02/17/2000	3:45 PM	28	3	7th&9th	SB
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02/17/2000	3:45 PM	34	3	7th&9th	SB
02/17/2000	3:45 PM	37	3	7th&9th	SB
02/17/2000	3:55 PM	32	3	7th&9th	SB
02/17/2000	3:55 PM	28	3	7th&9th	SB
02/17/2000	3:55 PM	37	3	7th&9th	SB
02/17/2000	3:55 PM	37	3	7th&9th	SB
02/17/2000	3:55 PM	37	3	7th&9th	SB
02/17/2000	3:55 PM	27	3	7th&9th	SB
02/17/2000	3:55 PM	27	3	7th&9th	SB
02/17/2000	3:55 PM	24	3	7th&9th	SB
02/17/2000	3:55 PM	43	3	7th&9th	SB
02/17/2000	3:55 PM	20	3	7th&9th	SB
02/17/2000	3:55 PM	20	3	7th&9th	SB

02/17/2000	3:55 PM	21	3	7th&9th	SB
02/17/2000	3:55 PM	17	3	7th&9th	SB
02/17/2000	3:55 PM	16	3	7th&9th	SB
02/17/2000	3:55 PM	28	3	7th&9th	SB
02/17/2000	3:55 PM	35	3	7th&9th	SB
02/17/2000	3:55 PM	25	3	7th&9th	SB
02/17/2000	3:55 PM	34	3	7th&9th	SB
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02/17/2000	3:55 PM	25	3	7th&9th	SB
02/17/2000	3:55 PM	38	3	7th&9th	SB
02/17/2000	3:55 PM	33	3	7th&9th	SB
02/17/2000	3:55 PM	31	3	7th&9th	SB
02/17/2000	3:55 PM	42	3	7th&9th	SB
02/17/2000	3:55 PM	24	3	7th&9th	SB
02/17/2000	3:55 PM	24	3	7th&9th	SB
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02/17/2000	4:05 PM	34	3	7th&9th	SB
02/17/2000	4:05 PM	26	3	7th&9th	SB
02/17/2000	4:05 PM	25	3	7th&9th	SB
02/17/2000	4:05 PM	28	3	7th&9th	SB
02/17/2000	4:05 PM	30	3	7th&9th	SB
02/17/2000	4:05 PM	26	3	7th&9th	SB

02/17/2000	4:05 PM	26	3	7th&9th	SB
02/17/2000	4:05 PM	34	3	7th&9th	SB
02/17/2000	4:05 PM	28	3	7th&9th	SB
02/17/2000	4:05 PM	26	3	7th&9th	SB
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02/17/2000	4:15 PM	31	3	7th&9th	SB
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02/17/2000	4:15 PM	38	3	7th&9th	SB
02/17/2000	4:15 PM	39	3	7th&9th	SB
02/17/2000	4:15 PM	36	3	7th&9th	SB

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02/17/2000	4:15 PM	33	3	7th&9th	SB
02/17/2000	4:15 PM	29	3	7th&9th	SB
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02/17/2000	4:25 PM	24	3	7th&9th	SB
02/17/2000	4:25 PM	25	3	7th&9th	SB

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02/17/2000	4:25 PM	20	3	7th&9th	SB
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02/17/2000	4:35 PM	32	3	7th&9th	SB
02/17/2000	4:35 PM	27	3	7th&9th	SB

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02/17/2000	4:35 PM	23	3	7th&9th	SB
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02/24/2000	1:00 PM	22	4	13th&5th	SB

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02/24/2000	2:35 PM	22	4	7th&9th	SB
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02/24/2000	2:15 PM	24	5	7th&9th	SB
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02/24/2000	2:25 PM	23	5	7th&9th	SB
02/24/2000	2:25 PM	28	5	7th&9th	SB