MEMORANDUM

To: UDOT/WFRC

From: Avenue Consultants

Date: September 24, 2018

Subject: Statewide Weekday, Seasonal, and Truck Factors

This memo summarizes the steps used to calculate weekday and seasonal volume factors and truck percentages for all segments on the USTM master segment file. Continuous Count Station (CCS) data was used to calculate the weekday and seasonal factors. Published truck data for all state routes was used for the truck factors. Recommendations for improvements to the data or the process are also included.

WEEKDAY FACTORS

Weekday factors are used to calculate Average Weekday Traffic (AWDT) by multiplying the factor by the AADT. Factors were calculated for segments based on functional class groupings and area type. The following steps were used to calculate this factor:

- CCS data was aggregated to AADT and AWDT by year for 2013 through 2017, excluding holidays.
- Weekday factors for each CCS were calculated for each year, and the average of the 5 years was used.
- Each CCS was associated with both an area type and a functional class.
- Area type (Rural, Transition, Suburban, Urban, CBD) was assigned for each segment based on the area type through which the segment ran for the greatest distance, using the USTM TAZ shapefile with area type designations. The area types were derived from a USTM 2015 model run.
- Functional class was taken from USTM network by joining each CCS to the nearest link. Four functional class groupings were used: Freeways, Expressways, Arterials (including collectors), and Canyons. Freeways were further subdivided into individual routes: I-15, I-215, I-70, I-80, I-84, Legacy, SR-201. Function class assignment was refined with manual adjustments in select locations.
- Weekday factors were then cross-classified to area type and functional class using a weighted average by AADT of the CCSs in each group.
- The master segment shapefile was joined to TAZ shapefile to find area type for each segment.
- For non-freeway segments weekday factors were assigned to segments based on area type and functional class.
- For freeway segments on each individual route, weekday factors were generally assigned to urban/suburban and rural/transition area. Factors were then manually adjusted between area types using linear interpolation with individual CCSs as known inflection points.

Table 1 shows the resulting weekday factors by functional class group and area type. Additionally, a figure is attached showing the roadway functional class groups for each segment and the underlying area type.

Table 1. Weekday Factors by Functional Class Group and Area Type

Functional Class Group	Area Type					All Area Types
	Rural	Transition	Suburban	Urban	CBD	
Expressway	1.041	1.041	1.088	1.122	1.122	--
Arterial	0.938	1.011	1.117	1.074	1.074	--
Freeways						
I-15	0.904	0.961	1.057	1.057	1.057	--
I-215	--	--	--	--	--	1.123
I-70	--	--	--	--	--	0.963
I-80	0.929	0.974	1.019	1.100	1.100	--
I-84 West	--	--	--	--	--	0.943
I-84 East	--	--	--	--	--	0.986
Legacy	--	--	--	--	--	1.214
SR-201	--	--	--	--	--	1.105
US-40	--	--	--	--	--	1.006

**Freeways include manual adjustments to smooth the transition between area types.*

MONTH AND SEASON FACTORS

Month and season factors are adjustments applied to AADTs to calculate average daily traffic for a given month or season. Factors were calculated for all segments using the following steps:

- Month and season factors for each CCS were calculated for each year 2013 through 2017, and then the average of the 5 years was used.
- CCSs were aggregated into geographic regions based on similar seasonal characteristics.
- Further division into area type and AADT bins created more uniform groupings.
- Month and season factors for each geography, area type, and volume grouping were calculated as averages weighted by AADT of the CSSs for each respective group.
- The factors were then applied to all roadway segments of the same group.
- To smooth out transitions between geographic regions or area types, linear interpolation of factors was done manually.

The following are some important notes regarding classification:

- The largest geographic bin is the Statewide Arterials & Expressways. The group was further divided into area type. The rural arterials showed a large variation, so they were further subdivided again into volume classes for low, mid, and upper volumes, which helped to reduce variation within bins. The other groups, such as the many canyons, are exceptions from this large statewide category.
- Many northern canyons that have their own CCS stations were divided into separate categories because they are unique in their seasonal variation.

- Rural recreational routes with low volumes (<2,500 vpd) were separated into their own category. A subset of this group includes is for routes that are closed during winter. While there is only one CCS providing data for each of these groups, the monthly variation seemed reasonably representative.
- The Southeast Utah geography consists of most of the area east of I-15 and south of I-70, excluding the cities along those corridors. The low volume class for this geography contains mostly recreational routes that experience a wide variation in seasonal traffic. National Park visitor data was used to supplement the CCS data for this area.
- Freeways were treated individually, and manual adjustments were made at urban area type transitions to smooth out the change in factors.

Table 2 contains the factors for each month and season for each grouping. Additionally, a figure is attached showing the geographic areas and, where applicable, the volume bins for each segment.

Table 2. Month and Season Factors for Geography, Area Type, and AADT Bin

Statewide	Area Type	AADT	# CCSs	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Winter	Spring	Summer	Fall
Arterials & Expressways	Rural	Low[1]	4	0.881	0.815	0.862	0.949	1.023	1.079	1.092	1.080	1.092	1.060	1.081	0.956	0.852	1.017	1.088	1.033
		Mid	10	0.874	0.772	0.827	0.926	0.970	1.053	1.170	1.204	1.147	1.065	1.044	0.891	0.824	0.982	1.174	1.000
		High	3	0.928	0.846	0.890	0.937	0.954	1.021	1.090	1.131	1.134	1.071	1.045	0.931	0.888	0.970	1.118	1.016
	Transition		6	0.927	0.851	0.896	0.980	1.015	1.057	1.067	1.039	1.067	1.055	1.043	0.973	0.892	1.017	1.057	1.022
	Suburban		10	0.956	0.885	0.954	1.001	1.010	1.029	1.038	1.009	1.033	1.044	1.032	0.978	0.936	1.013	1.026	1.018
	Urban/CBD		11	0.986	0.932	0.978	1.010	1.014	1.023	1.021	0.994	1.018	1.022	1.004	0.986	0.965	1.016	1.011	1.004
Southeast Utah		**AADT**	**# CCSs**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Winter**	**Spring**	**Summer**	**Fall**
Arterials & Expressways		Low[2]	1[3]	0.407	0.316	0.412	0.793	1.091	1.416	1.491	1.472	1.336	1.440	1.129	0.638	0.378	0.970	1.118	1.016
		Mid	7	0.784	0.655	0.709	0.915	1.002	1.133	1.223	1.267	1.188	1.145	1.050	0.860	0.716	1.017	1.226	1.018
Washington County			**# CCSs**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Winter**	**Spring**	**Summer**	**Fall**
Arterial			3	1.017	0.961	1.030	1.051	1.045	1.003	0.959	0.935	0.972	0.994	1.025	1.012	1.003	1.033	0.955	1.010
Expressway			4	0.950	0.842	0.961	1.030	1.047	1.032	1.007	0.993	1.035	1.039	1.046	1.008	0.918	1.036	1.012	1.031
I-15			3	0.941	0.848	0.909	1.038	1.034	1.006	1.029	1.099	1.070	0.987	1.026	0.991	0.899	1.026	1.066	1.001
Freeways	**Area Type**		**# CCSs**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Winter**	**Spring**	**Summer**	**Fall**
I-15	Rural		5	0.911	0.772	0.851	1.021	1.041	1.018	1.110	1.159	1.089	0.987	1.025	0.984	0.844	1.027	1.119	0.999
	Transition		3	0.966	0.838	0.902	0.986	1.001	1.025	1.079	1.094	1.086	1.020	1.022	0.967	0.902	1.004	1.086	1.003
	Suburban		4	0.975	0.853	0.946	1.004	1.018	1.011	1.052	1.043	1.051	1.020	1.014	0.976	0.920	1.011	1.049	1.003
	Urban		4	0.990	0.879	0.936	0.984	1.028	1.030	1.038	1.020	1.039	1.021	1.025	0.989	0.938	1.014	1.033	1.012
I-80	Rural		5	0.908	0.866	0.883	0.939	0.917	0.987	1.114	1.184	1.172	1.064	1.009	0.918	0.886	0.948	1.156	0.997
	Urban		2	0.974	0.921	0.961	0.998	0.979	1.009	1.041	1.025	1.049	1.033	1.024	0.979	0.952	0.995	1.038	1.012
I-215			1	0.982	0.933	0.981	1.011	1.019	1.017	1.025	0.999	1.011	1.016	1.016	0.976	0.966	1.015	1.012	1.003
Legacy			7	0.957	0.925	0.949	0.992	1.006	1.015	1.048	1.013	1.045	1.034	1.025	0.988	0.943	1.004	1.035	1.015
SR-201			4	0.967	0.924	0.978	1.020	1.027	1.057	1.001	0.962	1.036	1.014	1.012	0.980	0.956	1.035	0.985	1.002
I-70			2	0.762	0.633	0.649	0.930	0.979	1.133	1.329	1.353	1.216	1.079	0.995	0.841	0.681	1.014	1.299	0.971
I-84			2	0.868	0.756	0.797	0.914	0.938	1.019	1.169	1.242	1.206	1.051	1.019	0.929	0.807	0.957	1.206	0.999
US-40			1	0.950	0.896	0.901	0.927	0.894	0.969	1.129	1.173	1.155	1.080	0.980	0.903	0.910	0.930	1.153	0.994
Exception Areas			**# CCSs**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Winter**	**Spring**	**Summer**	**Fall**
Alpine Loop			2	0.289	0.273	0.303	0.397	0.499	1.005	1.919	2.011	1.769	1.544	1.378	0.429	0.288	0.634	1.900	1.117
Bear Lake			2	0.468	0.420	0.460	0.488	0.565	0.876	1.592	2.524	2.117	1.104	0.707	0.477	0.449	0.643	2.078	0.763
Big Cottonwood			1	1.077	1.138	1.150	1.074	0.673	0.605	1.177	1.333	1.204	1.012	0.864	0.666	1.122	0.784	1.238	0.847
Cedar Breaks			1[3]	0.488	0.337	0.385	0.450	0.585	0.944	1.620	1.932	1.684	1.551	1.236	0.633	0.404	0.660	1.746	1.140
Little Cottonwood / Snowbasin			1	1.213	1.315	1.401	1.359	0.983	0.624	0.778	1.007	0.992	0.930	0.775	0.670	1.310	0.989	0.926	0.792
Moab			1	0.539	0.418	0.520	1.006	1.248	1.367	1.272	1.210	1.115	1.215	1.159	0.767	0.498	1.207	1.199	1.047
ParkCity			2	1.074	1.142	1.076	1.078	0.820	0.841	1.006	1.111	1.092	0.983	0.925	0.885	1.097	0.913	1.070	0.931
Rural Recreational Low Volume			1	0.578	0.570	0.601	0.710	0.820	1.076	1.563	1.692	1.461	1.161	0.948	0.667	0.583	0.869	1.572	0.926
Rural Recreational Low Volume - Closed Winter			1	0.382	0.228	0.223	0.233	0.269	0.812	1.688	2.264	2.030	1.531	1.406	0.634	0.278	0.438	1.994	1.190

[1] AADT Ranges. Low: 0 to 2,500; Mid: 2,500 to 12,500; High: Above 12,500. [2] AADT Ranges. Low: 0 to 1,500; Mid: Above 1,500. [3] CCS Data supplemented with visitor data from national parks.

TRUCK FACTORS

Truck percentages at the segment level for all state routes for 2012-2016 for both single unit (SU) and combination unit (CU) trucks were downloaded from UDOT's website. The truck factors are the averages of 2014 through 2016 truck percentages. The range only included the most 3 recent years due to the inconsistency of truck data for earlier years (2012-2013) for a significant number of segments.

Truck data was only available for state routes. Estimates were produced for all non-state routes. Average truck percentages for state routes were calculated using the same groupings as the month and season factors. Reduction ratios were then applied to these averages to account for the lower truck percentages that are typically experienced on lower function type roads. A 0.25 reduction factor was used for most groups except for groups with low volumes where a 0.10 reduction factor was used. The resulting factors were applied to all non-state routes of the same grouping.

SHAPEFILE FIELD DESCRIPTIONS

- Two shapefiles are included with this memo: one containing segments and factor data and one containing the geographies used for seasonal factor groupings. The shapefile MSegs_20170828b_Factors_20180919.shp contains all the weekday, seasonal, and truck factors. A description of each field is contained in Other UDOT groups, unrelated to the UDOT Traffic Statistics group, collect large amounts of traffic data every year that is used for its intended purpose and then rarely used again. It would be useful if there were a central repository for this data, so it could be shared across the organization and used for other projects and purposes.

Table 3. The shapefile SeasonalFactorGeographies_20180919.shp contains the shapes used for seasonal factor geographies that are applied to the segments within each area, except for freeways that were calculated separately.

RECOMMENDATIONS

The following are recommendations to UDOT for improving the data or process for calculating segment factors:

- Rural areas saw the highest variation in factors and were often the most difficult to aggregate into tight factor ranges. Additional CCS locations throughout rural areas would help with provide more representative aggregation of segments. This is especially true of recreational routes in general, and low volume recreational routes specifically that can experience wide variations in travel patterns. In particular, data on northern recreational routes is very thin.
- Truck percentages appear to be very high on many routes when compared to informal observations, such as nearly 40% trucks on Bangerter Highway near 7800 South or the 30% trucks reported on large portions of suburban I-15. More testing and refining of the truck counting and reporting process would help increase confidence in the results.
- Making CCS truck volumes available at an hourly level throughout the year would allow for the development of more detailed factors. It is likely that weekday and seasonal factors vary between passenger vehicles and trucks. Additional truck data would make it possible to create factors by vehicle type.

- Easy access to UDOT's 48-hour counts that are done throughout the state would provide an additional wealth of information to better inform this entire process and would allow for the creation of time-of-day and even directional factors.
- The process for calculating these factors involved a lot of time in reviewing the data and grouping stations appropriately. It is recommended that UDOT Planning define a process, in close coordination with UDOT Traffic Statistics, to annually update the factors based on new data available each year.
- Other UDOT groups, unrelated to the UDOT Traffic Statistics group, collect large amounts of traffic data every year that is used for its intended purpose and then rarely used again. It would be useful if there were a central repository for this data, so it could be shared across the organization and used for other projects and purposes.

Table 3. MSegs_20170828b_Factors_20180919.shp Fields and Descriptions

Field	Description
AWDTFACFC	Functional Class Group for Weekday (AWDT) Factor
AWDTFACAT	Area Type Group for Weekday (AWDT) Factor
AWDTFAC	Weekday (AWDT) Factor
AWDTMANADJ	Flag for Manual Adjustment of Weekday (AWDT) Factor
SSNFACGEO	Season/Month Factor Geography
SSNFACAT	Season/Month Factor Area Type Group
SSNFACVOL	Season/Month Factor Volume Group
FACJAN	Month Factor for January
FACFEB	Month Factor for February
FACMAR	Month Factor for March
FACAPR	Month Factor for April
FACMAY	Month Factor for May
FACJUN	Month Factor for June
FACJUL	Month Factor for July
FACAUG	Month Factor for August
FACSEP	Month Factor for September
FACOCT	Month Factor for October
FACNOV	Month Factor for November
FACDEC	Month Factor for December
FACWIN	Season Factor for Winter
FACSPR	Season Factor for Spring
FACSUM	Season Factor for Summer
FACFAL	Season Factor for Fall
FACMAXMNTH	Month (1-12) of Maximum Month Factor
FACMAX	Maximum Month Factor

Field	Description
SSNMANADJ	Flag for Season/Month Factor Manual Adjustment
SUTRUCKS	Percent Single Unit Trucks
CUTRUCKS	Percent Combination Unit Trucks