Application of the MORPC Micro-Simulation Model: New Starts Review

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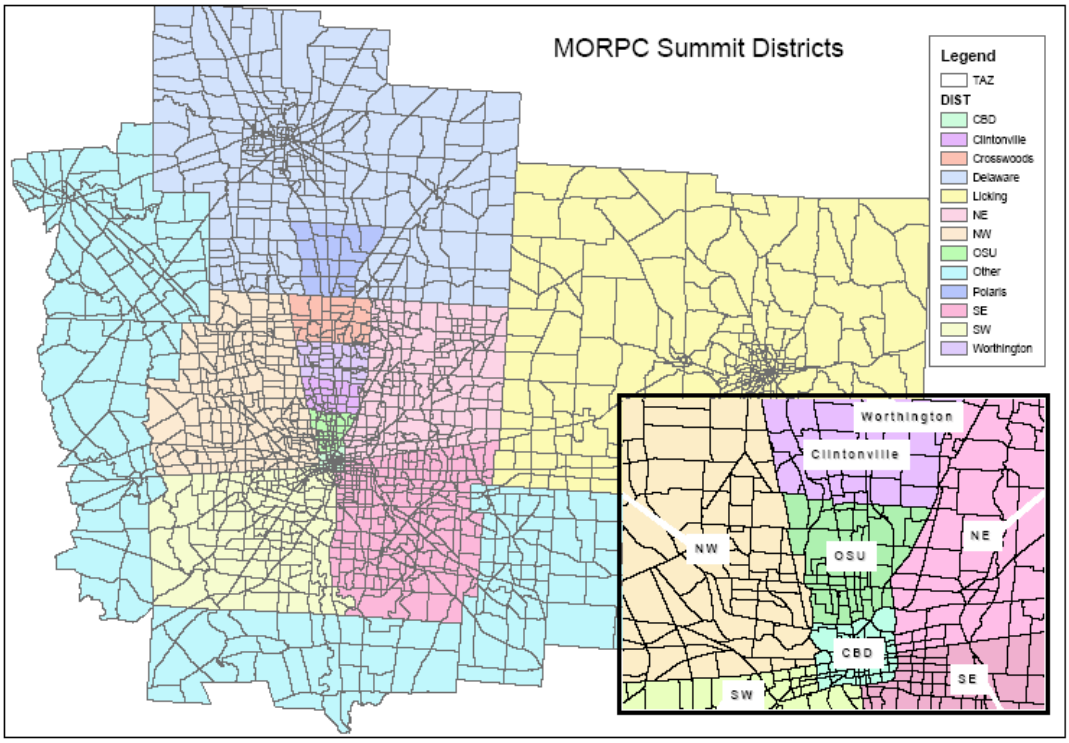
The Federal Transit Administration (FTA) has very high standards for travel demand models used to generate ridership forecasts for its New Starts program. It is important to assess a model's ability to meet these standards early on so that potential FTA concerns with the forecasts or model structure can be addressed in a timely manner. Model structure changes require long, iterative development times.

The Mid-Ohio Regional Planning Commission (MORPC) micro-simulation model is being used to generate forecasts for the North Corridor Transit Project (NCTP) – currently in the Draft Environmental Impact Statement (DEIS) stage – with a potential New Starts submittal within the next few years. The NCTP is analyzing various travel modes along a 13-mile corridor. The corridor includes three major employment centers – the Central Business District (CBD), the Ohio State University (OSU), and the Crosswoods/Polaris area – interspersed with large residential areas.

The NCTP team members investigated many areas of the MORPC model, including its overall structure, auto and transit travel times, path building parameters, mode choice coefficient values, and results. The analysis of the model's trip distribution and user benefit (UB) results will be discussed, as these two elements have been identified as concerns by the FTA on other New Starts projects.

The regional figures were divided into 13 districts for analysis purposes (shown in Figure 1). Six districts are for the corridor: the Central Business District (CBD), Ohio State University (OSU) area, Clintonville, Worthington, Crosswoods, and Polaris. The remaining area of Franklin County is divided into four areas: Northwest, Northeast, Southeast, and Southwest. The remaining area of Delaware County is another district. Licking County is its own district. The portions of the surrounding counties, including Pickaway and Union, are in the final district.

Figure 1: Districts used for analysis



Travel Distribution

Travel distribution is one of the most difficult aspects of travel demand to model effectively. FTA has identified travel distribution as a potential upstream model error that can lead to poorly calibrated mode choice models containing large, unexplainable alternative specific constants. To explore the reliability of the work-component of the distribution model, the simulated 2000 year work tour distribution was compared to the 2000 Census Transportation Planning Package (CTPP), which captures work journeys. The first step was to compare the region-wise magnitude of modeled work trip tours to CTPP. On a region-wide basis, the model estimates 660,031 work tours compared to 630,550 CTPP records—a difference of only 4.7 percent. Next, district-to-district tours were compared to the CTPP (scaled so that regional CTPP records match modeled journeys). The modeled work tour distribution is shown in Table 1. The CTPP journey distribution is shown in Table 2. Table 3 displays the ratio of the modeled to the observed distribution.

Table 1: 2000 Modeled Work Tours

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	277	154	47	34	53	7	8	338	167	293	170	5	12	1,565
2 - OSU	3,646	3,586	1,270	1,077	1,138	200	270	5,846	3,061	2,752	1,854	48	165	24,913
3 - Clintonville	3,706	2,565	1,612	1,447	1,686	233	418	5,346	3,281	1,966	1,181	65	144	23,650
4 - Worthington	4,085	1,903	1,434	2,557	3,575	536	929	5,621	5,278	1,842	983	141	213	29,097
5 - Crosswoods	3,197	1,534	1,228	2,086	5,144	1,094	1,597	5,883	4,940	1,498	826	178	293	29,498
6 - Polaris	625	294	216	382	1,235	464	830	1,478	963	285	146	42	120	7,080
Corridor Total	15,536	10,036	5,807	7,583	12,831	2,534	4,052	24,512	17,690	8,636	5,160	479	947	115,803
7 - Delaware	2,820	1,241	831	1,565	4,431	1,851	12,350	7,650	5,210	1,613	865	630	1,635	42,692
8 - NW	15,631	8,178	4,407	3,957	7,360	1,467	3,150	49,480	8,067	6,606	8,857	212	2,895	120,267
9 - NE	11,676	5,134	2,846	4,207	6,472	1,148	2,423	10,431	22,156	10,979	3,146	1,444	906	82,968
10 - SE	17,249	6,414	1,972	1,981	2,496	391	705	12,093	17,788	36,222	8,876	1,485	3,228	110,900
11 - SW	7,265	4,542	1,182	1,025	1,230	234	436	20,153	4,420	9,439	14,984	113	1,923	66,946
12 - Licking	2,645	811	407	721	1,094	253	1,202	1,781	6,342	5,713	822	46,456	1,606	69,853
13 - Other	4,877	1,570	615	585	1,173	263	1,536	7,709	4,166	10,641	3,476	2,830	11,161	50,602
Non-Corridor Tot	62,163	27,890	12,260	14,041	24,256	5,607	21,802	109,297	68,149	81,213	41,026	53,170	23,354	544,228
Regional Total	77,699	37,926	18,067	21,624	37,087	8,141	25,854	133,809	85,839	89,849	46,186	53,649	24,301	660,031

Table 2: CTPP 2000 Journeys (scaled to modeled work tours)

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	535	243	33	33	47	7	15	335	182	195	88	15	24	1,752
2 - OSU	4,008	6,094	833	1,030	1,023	127	296	4,887	2,755	1,778	926	174	104	24,036
3 - Clintonville	3,609	3,001	2,256	1,127	1,517	311	416	4,201	2,827	1,695	816	94	99	21,969
4 - Worthington	3,761	2,509	1,380	3,745	3,499	505	542	5,125	4,760	2,107	963	244	182	29,322
5 - Crosswoods	3,730	1,633	1,051	1,733	6,194	1,192	1,083	5,255	5,280	1,792	859	210	130	30,142
6 - Polaris	698	321	240	312	995	995	934	1,340	794	350	170	16	58	7,223
Corridor Total	16,341	13,801	5,793	7,982	13,275	3,137	3,286	21,142	16,598	7,917	3,823	753	597	114,444
7 - Delaware	3,318	1,524	844	1,012	3,887	2,948	13,648	6,970	5,695	1,907	789	385	860	43,788
8 - NW	16,883	9,268	3,567	2,517	6,983	1,469	2,256	55,319	8,268	7,483	7,429	561	1,787	123,790
9 - NE	11,278	3,910	1,849	3,469	6,704	1,253	1,925	10,901	29,014	9,764	2,769	1,255	530	84,620
10 - SE	16,179	4,264	1,495	1,948	3,585	477	902	14,371	19,233	35,442	7,513	1,340	1,867	108,616
11 - SW	7,675	2,338	1,104	950	2,191	315	390	19,977	4,790	7,996	18,272	316	1,049	67,365
12 - Licking	2,437	667	310	642	1,429	268	722	3,111	7,698	5,144	1,010	39,761	716	63,914
13 - Other	4,594	1,221	524	621	1,395	283	574	8,767	5,521	9,164	3,425	1,539	15,868	53,494
Non-Corridor Tot	62,364	23,192	9,693	11,159	26,174	7,012	20,417	119,416	80,219	76,901	41,207	45,157	22,677	545,587
Regional Total	78,704	36,993	15,486	19,141	39,449	10,149	23,703	140,558	96,817	84,817	45,029	45,910	23,274	660,031

Table 3: Ratio of Model over Scaled CTPP

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	0.52	0.63	1.40	1.02	1.13	0.96	0.55	1.01	0.92	1.50	1.93	N/A	0.50	0.89
2 - OSU	0.91	0.59	1.52	1.05	1.11	1.58	0.91	1.20	1.11	1.55	2.00	0.28	1.59	1.04
3 - Clintonville	1.03	0.85	0.71	1.28	1.11	0.75	1.01	1.27	1.16	1.16	1.45	0.69	1.45	1.08
4 - Worthington	1.09	0.76	1.04	0.68	1.02	1.06	1.71	1.10	1.11	0.87	1.02	0.58	1.17	0.99
5 - Crosswoods	0.86	0.94	1.17	1.20	0.83	0.92	1.47	1.12	0.94	0.84	0.96	0.85	2.26	0.98
6 - Polaris	0.90	0.91	0.90	1.22	1.24	0.47	0.89	1.10	1.21	0.82	0.86	2.67	2.08	0.98
Corridor Total	0.95	0.73	1.00	0.95	0.97	0.81	1.23	1.16	1.07	1.09	1.35	0.64	1.59	1.01
7 - Delaware	0.85	0.81	0.98	1.55	1.14	0.63	0.90	1.10	0.91	0.85	1.10	1.64	1.90	0.97
8 - NW	0.93	0.88	1.24	1.57	1.05	1.00	1.40	0.89	0.98	0.88	1.19	0.38	1.62	0.97
9 - NE	1.04	1.31	1.54	1.21	0.97	0.92	1.26	0.96	0.76	1.12	1.14	1.15	1.71	0.98
10 - SE	1.07	1.50	1.32	1.02	0.70	0.82	0.78	0.84	0.92	1.02	1.18	1.11	1.73	1.02
11 - SW	0.95	1.94	1.07	1.08	0.56	0.74	1.12	1.01	0.92	1.18	0.82	0.36	1.83	0.99
12 - Licking	1.09	1.22	1.31	1.12	0.77	0.94	1.66	0.57	0.82	1.11	0.81	1.17	2.24	1.09
13 - Other	1.06	1.29	1.17	0.94	0.84	0.93	2.68	0.88	0.75	1.16	1.01	1.84	0.70	0.95
Non-Corridor Tot	1.00	1.20	1.26	1.26	0.93	0.80	1.07	0.92	0.85	1.06	1.00	1.18	1.03	1.00
Regional	0.99	1.03	1.17	1.13	0.94	0.80	1.09	0.95	0.89	1.06	1.03	1.17	1.04	1.00

Overall, the modeled trip distribution for work purposes appears to be as good as or better than comparable models used elsewhere in the United States. The model is representing trips to the CBD very closely, within 1% regionally. Work trips from within the corridor to the CBD are under-represented by 5%. Regionally, the model is over-representing trips to Ohio State University (OSU) by just 3%. There are specific travel markets that are weak, including a 27% under-estimation of tours from the corridor to OSU. Work tour productions and attractions are well estimated by the model. Almost all markets are represented within 10% of the CTPP totals.

District-to-district tours for all purposes were compared to the CTPP and household travel survey. The CTPP results were scaled as before, but the survey records were not scaled. The modeled work tour distribution is shown in Table 4. The observed journey distribution is shown in Table 5. Table 6 displays the ratio of the modeled to the observed distribution.

Table 4: 2000 Modeled Tours (All Purposes)

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	11,358	4,037	911	505	343	33	45	4,803	2,984	5,690	3,605	17	74	34,405
2 - OSU	8,979	30,066	6,937	4,219	2,386	330	446	16,877	10,475	9,220	5,139	67	242	95,383
3 - Clintonville	6,692	11,397	10,899	7,733	4,024	453	789	14,224	10,865	5,016	2,462	83	179	74,816
4 - Worthington	6,554	7,134	7,748	19,298	12,284	1,200	2,123	14,011	17,879	4,047	1,787	217	312	94,594
5 - Crosswoods	4,485	3,835	4,175	12,245	25,199	3,793	5,261	15,260	16,069	2,769	1,290	227	421	95,029
6 - Polaris	779	545	540	1,354	4,311	3,781	3,579	3,021	2,590	466	202	51	153	21,372
Corridor Total	38,847	57,014	31,210	45,354	48,547	9,590	12,243	68,196	60,862	27,208	14,485	662	1,381	415,599
7 - Delaware	3,333	2,005	1,811	4,332	10,336	6,463	64,039	17,521	15,176	2,414	1,249	1,106	2,852	132,637
8 - NW	25,439	24,045	13,061	14,512	18,252	2,948	8,755	200,574	16,625	14,616	31,046	239	5,448	375,560
9 - NE	20,777	15,517	11,535	18,394	16,888	2,390	8,527	20,072	114,245	42,893	6,721	3,036	1,913	282,908
10 - SE	32,556	14,962	5,239	4,557	3,684	521	1,029	21,378	48,440	193,418	26,120	3,619	9,964	365,487
11 - SW	14,930	10,230	2,805	2,128	1,738	292	605	48,760	8,917	27,426	91,130	134	3,374	212,469
12 - Licking	3,106	1,058	596	1,197	1,474	311	2,141	2,132	12,748	13,921	1,051	173,182	4,590	217,507
13 - Other	6,448	2,457	959	1,041	1,672	419	3,402	16,179	7,180	32,040	11,901	6,436	67,320	157,454
Non-Corridor Tot	106,589	70,274	36,006	46,161	54,044	13,344	88,498	326,616	223,331	326,728	169,218	187,752	95,461	1,744,022
Regional Total	145,436	127,288	67,216	91,515	102,591	22,934	100,741	394,812	284,193	353,936	183,703	188,414	96,842	2,159,621

Table 5: 2000 Scaled CTPP+Survey Journeys/Tours

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	13,383	1,619	1,071	584	137	7	15	1,433	733	1,372	1,253	307	24	21,938
2 - OSU	12,252	59,348	11,444	4,499	2,776	238	870	23,174	15,758	5,681	2,852	1,200	104	140,197
3 - Clintonville	4,674	8,899	38,017	11,486	3,474	591	644	13,130	7,981	2,326	892	184	181	92,479
4 - Worthington	6,206	4,995	7,759	27,042	13,094	755	2,027	12,639	7,668	3,010	1,236	559	707	87,697
5 - Crosswoods	6,476	2,628	2,491	14,129	23,326	2,560	2,417	10,297	11,303	3,055	1,855	284	130	80,951
6 - Polaris	698	1,455	240	312	1,818	2,023	1,527	1,340	794	350	385	16	58	11,016
Corridor Total	43,689	78,944	61,022	58,054	44,625	6,174	7,500	62,012	44,237	15,794	8,474	2,550	1,204	434,278
7 - Delaware	3,649	3,058	1,326	2,896	6,108	4,116	48,491	19,495	14,633	2,741	857	394	1,461	109,226
8 - NW	23,000	18,883	7,936	9,562	13,482	2,163	6,079	208,349	13,869	11,284	16,247	631	2,509	333,994
9 - NE	19,776	9,640	12,320	12,511	13,911	1,436	9,314	16,403	126,005	34,800	6,028	3,106	1,908	267,157
10 - SE	30,593	10,668	7,423	6,296	6,624	633	902	28,170	54,719	233,848	14,619	5,508	3,134	403,137
11 - SW	10,129	2,888	2,323	1,760	2,249	315	1,410	33,328	6,264	11,987	71,409	405	1,181	145,650
12 - Licking	3,404	1,810	1,046	1,537	1,917	322	3,515	4,446	9,986	11,088	1,491	190,467	1,181	232,209
13 - Other	4,882	1,378	524	704	1,549	283	2,285	13,504	6,066	17,013	6,169	2,714	49,320	106,389
Non-Corridor Tot	95,433	48,325	32,898	35,266	45,840	9,267	71,996	323,695	231,542	322,762	116,820	203,225	60,694	1,597,762
Regional Total	139,121	127,269	93,920	93,320	90,465	15,441	79,496	385,707	275,779	338,555	125,293	205,775	61,898	2,032,040

Table 6: Ratio of Modeled to Observed Tours

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	0.85	2.49	0.85	0.86	2.50	4.50	3.07	3.35	4.07	4.15	2.88	0.06	3.07	1.57
2 - OSU	0.73	0.51	0.61	0.94	0.86	1.39	0.51	0.73	0.66	1.62	1.80	0.06	2.34	0.68
3 - Clintonville	1.43	1.28	0.29	0.67	1.16	0.77	1.23	1.08	1.36	2.16	2.76	0.45	0.99	0.81
4 - Worthington	1.06	1.43	1.00	0.71	0.94	1.59	1.05	1.11	2.33	1.34	1.45	0.39	0.44	1.08
5 - Crosswoods	0.69	1.46	1.68	0.87	1.08	1.48	2.18	1.48	1.42	0.91	0.70	0.80	3.24	1.17
6 - Polaris	1.12	0.37	2.25	4.34	2.37	1.87	2.34	2.25	3.26	1.33	0.53	3.25	2.66	1.94
Corridor Total	0.89	0.72	0.51	0.78	1.09	1.55	1.63	1.10	1.38	1.72	1.71	0.26	1.15	0.96
7 - Delaware	0.91	0.66	1.37	1.50	1.69	1.57	1.32	0.90	1.04	0.88	1.46	2.81	1.95	1.21
8 - NW	1.11	1.27	1.65	1.52	1.35	1.36	1.44	0.96	1.20	1.30	1.91	0.38	2.17	1.12
9 - NE	1.05	1.61	0.94	1.47	1.21	1.66	0.92	1.22	0.91	1.23	1.12	0.98	1.00	1.06
10 - SE	1.06	1.40	0.71	0.72	0.56	0.82	1.14	0.76	0.89	0.83	1.79	0.66	3.18	0.91
11 - SW	1.47	3.54	1.21	1.21	0.77	0.93	0.43	1.46	1.42	2.29	1.28	0.33	2.86	1.46
12 - Licking	0.91	0.58	0.57	0.78	0.77	0.97	0.61	0.48	1.28	1.26	0.70	0.91	3.89	0.94
13 - Other	1.32	1.78	1.83	1.48	1.08	1.48	1.49	1.20	1.18	1.88	1.93	2.37	1.36	1.48
Non-Corridor Tot	1.12	1.45	1.09	1.31	1.18	1.44	1.23	1.01	0.96	1.01	1.45	0.92	1.57	1.09
Regional	1.05	1.00	0.72	0.98	1.13	1.49	1.27	1.02	1.03	1.05	1.47	0.92	1.56	1.06

Overall, the modeled trip distribution is very good, but not as good as the work tour distribution. The production districts have some noticeable variation, including over-estimating trips from Polaris, a suburban employment and retail center, by 94%. The attraction districts are generally much better. Tours attracted to the CBD and OSU, the two biggest employment centers in the region, are within 5%. It should be noted that the weighting and expansion factors are quite large due to the sample size of the household survey. This can lead to “lumpiness” in the observed data and make precise comparisons difficult.

User Benefits (UB)

User benefit results are reasonable if they can explain the benefits of the proposed build project. For example, corridor areas should accrue the most number of user benefits while areas outside of the corridor should receive minimal benefits. Major employment areas that benefit the most from the project should receive large user benefits. The district-to-district summary tables and “winners/losers” maps were reviewed for this analysis. The distribution of user benefits by travel market for HBW tours is shown in Table 7, and the distribution for all tours in shown in Table 8.

Table 7: User Benefit District Summary (HBW Tours)

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	(5)	21	(1)	1	9	3	2	(2)	1	1	-	-	-	30
2 - OSU	305	42	-	36	111	56	33	51	75	63	38	-	-	810
3 - Clintonville	66	17	(1)	3	21	9	6	2	3	4	3	-	-	133
4 - Worthington	141	46	1	2	21	13	9	8	3	8	5	-	-	257
5 - Crosswoods	239	67	13	16	40	5	7	24	13	14	7	-	-	445
6 - Polaris	135	32	7	14	25	(2)	-	16	23	7	5	-	-	262
Corridor Total	881	225	19	72	227	84	57	99	118	97	58	-	-	1,937
7 - Delaware	145	24	3	4	17	(2)	(1)	12	11	8	5	-	-	226
8 - NW	46	21	(2)	6	42	19	11	(13)	5	2	(6)	-	-	131
9 - NE	71	27	-	3	17	5	6	5	(1)	4	2	-	-	139
10 - SE	(6)	44	(3)	7	28	6	7	(11)	(1)	(3)	(10)	-	(1)	57
11 - SW	(4)	21	(1)	2	9	2	2	(7)	(1)	(2)	(2)	-	-	19
12 - Licking	4	1	-	-	-	-	-	-	-	-	-	-	-	5
13 - Other	(3)	3	-	-	1	-	-	-	-	-	-	-	-	1
Non-Corridor Tot	253	141	(3)	22	114	30	25	(14)	13	9	(11)	-	(1)	578
Regional Total	1,134	366	16	94	341	114	82	85	131	106	47	-	(1)	2,515

Table 8: User Benefit District Summary (All Tours)

District	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
1 - CBD	(6)	30	-	2	12	3	2	(2)	2	1	-	-	-	44
2 - OSU	373	54	5	62	161	65	37	61	94	84	54	-	-	1,050
3 - Clintonville	69	21	(3)	3	28	10	6	2	4	5	3	-	-	148
4 - Worthington	151	59	1	2	29	16	11	9	3	10	6	-	-	297
5 - Crosswoods	257	84	18	21	52	9	8	29	16	16	10	-	-	520
6 - Polaris	140	38	9	16	29	(2)	-	18	25	7	6	-	-	286
Corridor Total	984	286	30	106	311	101	64	117	144	123	79	-	-	2,345
7 - Delaware	148	26	4	5	19	(2)	(1)	13	12	9	5	-	-	238
8 - NW	49	25	(2)	7	47	21	11	(13)	6	2	(7)	-	-	146
9 - NE	77	33	1	4	22	7	6	5	(1)	5	1	-	-	160
10 - SE	-	54	(1)	8	34	7	7	(11)	-	(4)	(12)	-	(1)	81
11 - SW	(1)	28	-	3	12	2	2	(8)	(1)	(3)	(3)	-	-	31
12 - Licking	4	1	-	-	-	-	-	-	-	-	-	-	-	5
13 - Other	(3)	3	-	-	1	-	-	-	-	-	-	-	-	1
Non-Corridor Tot	274	170	2	27	135	35	25	(14)	16	9	(16)	-	(1)	662
Regional Total	1,258	456	32	133	446	136	89	103	160	132	63	-	(1)	3,007

The tables show that the MORPC AB model produces reasonable user benefit results. The majority of user benefits occur in the corridor. For work tours, 77% of user benefits are produced in corridor districts and 82% are destined for corridor districts. For all tours, the figures are 78% and 82%, respectively. Both tables have minimal level of benefits in intra-district markets. The CBD district has the highest level of benefits in terms of attractions.

The “winners/losers” maps show which zones receive the most benefit and dis-benefit from the project. They are extremely useful in evaluating whether the user benefit results are directly related to the proposed project. Zones that receive benefits are shaded in green with a darker color indicating higher benefits. Zones that receive dis-benefits are shaded in red with a darker color indicating more dis-benefit. Figure 2 shows the production and attraction maps for HBW-peak tours.

The maps are very good at explaining the benefits and dis-benefits of the project. The production map shows that a majority of the benefits are accrued by people living in the corridor, especially by those living near the rail stations. The red zones in the Worthington region reflect the longer travel times from the proposed project due as compared to the existing bus service. The attraction map has many green zones around stations near major employment areas, especially OSU and the northern suburbs.

Figure 2: Row (left) and Column (right) User Benefit Summaries