

PNNL-33718

Hanford Site Regional Population – 2020 Census

December 2022

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for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

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Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99354

Summary

The U.S. Department of Energy (DOE) conducts radiological operations in south-central Washington State. Population dose estimates must be performed to provide a measure of the impact from site radiological releases. Results of the U.S. 2020 Census were used to determine counts and distributions for the residential population located within 50 miles (80 kilometers) of several operating areas of the Hanford Site. Year 2010 was the first census year that a 50-mile population of a Hanford Site operational area exceeded the half-million mark. All five locations evaluated in this report for the year 2020 census exceeded the half-million mark for 50-mile populations.

Acronyms and Abbreviations

100K	DOE Hanford Site, 100-K Area
200E	DOE Hanford Site, 200-East Area
200W	DOE Hanford Site, 200-West Area
300 Area	DOE Hanford Site, 300 Area
400 Area	DOE Hanford Site, 400 Area
DOE	U.S. Department of Energy
GIS	Geographic Information Systems
HMS	Hanford Meteorological Station
km	kilometer(s); 1 km = 0.621 mi
mi	mile(s); 1 mi = 1.609 km
PFP	Plutonium Finishing Plant
WTP	Waste Treatment & Immobilization Plant

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1.0 Introduction

The 2020 U.S. Census data were used to update 50-mile (80-km) residential population data relative to five major operating areas of the U.S. Department of Energy Hanford Site in Washington State. This information updates prior Census evaluation reports:

- Beck et al. (1991), which provided data from the 1990 Census,
- Elliott et al. (2004), which provided data from the year 2000 Census, and
- Hamilton and Snyder (2011), which provided data from the year 2010 Census.

As in prior reports, for this 2020 Census report, the population within 50-miles is provided for a radial grid of 160 segments centered on each of five operating areas (see Section 2.0). As an example, Figure 1.1 indicates the Hanford Site boundary and county borders with the 50-mile grid centered on the Hanford Site, 200-West Area (200W). Gilliam, Morrow, and Umatilla Counties are in Oregon. All other counties are in Washington.

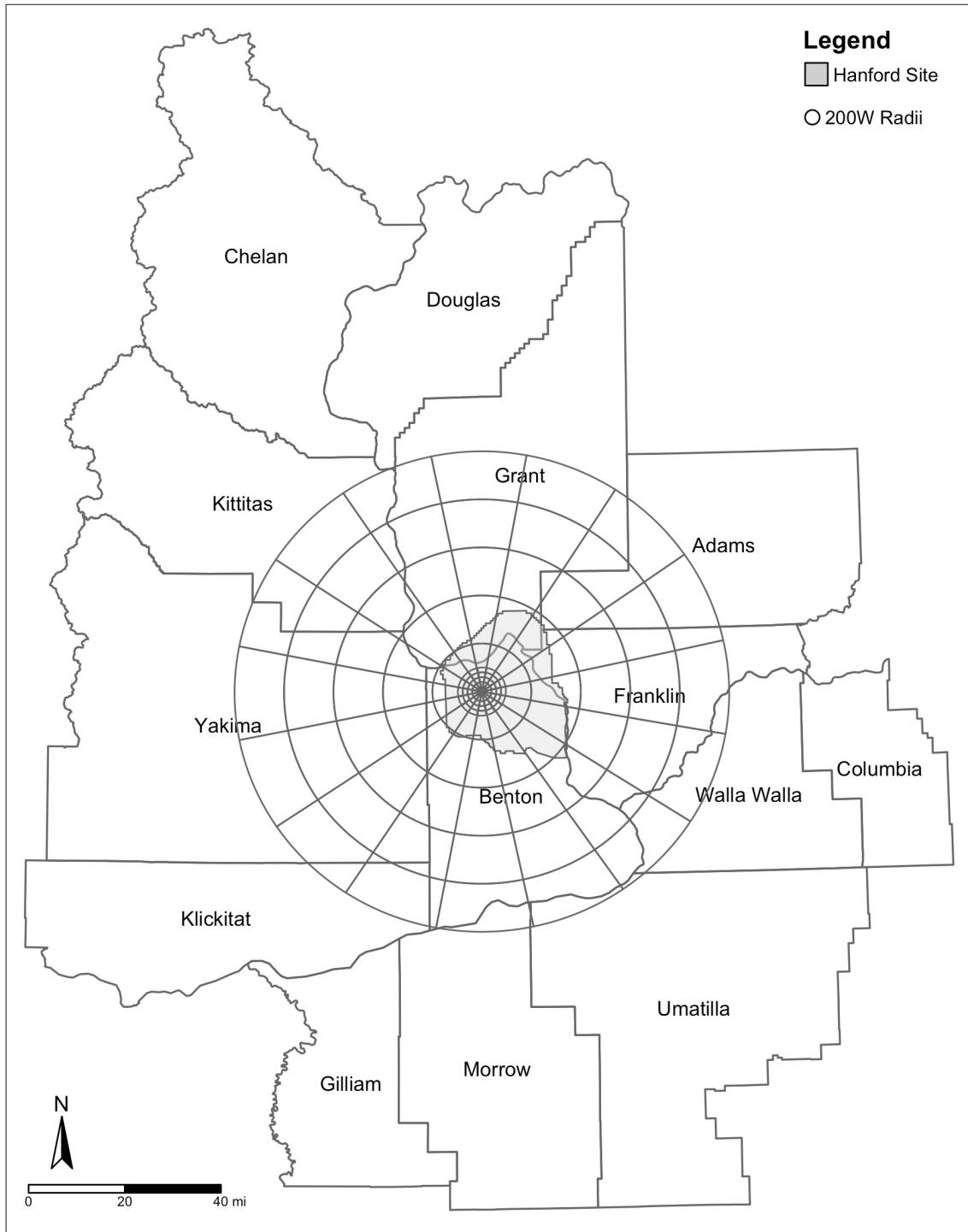


Figure 1.1. 200-West 50-mile Region and County Overlay

2.0 Data Evaluation

Statistical software, R (R Core Team 2022), with Geographic Information Systems (GIS) packages, sf (Pebesma 2018), tigris (Walker 2022), tmap (Tennekes 2018), ggplot2 (Wickham 2016), and tidycensus (Walker and Herman 2022), were used to create direction- and distance-specific circular grids centered on each of five Hanford Site locations: 100 K Area, 200W, eastern 200-East Area’s Waste Treatment & Immobilization Plant (200E [WTP]), 300 Area, and the 400 Area (Table 2.1; Figure 2.1). The grids contained concentric circles with radii of 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 miles, expanding from the point of one of five Hanford locations.

The 16 directional sectors of the grid were created using the four cardinal directions (N, E, S, W), the four ordinal directions (NE, SE, SW, NW), and the eight half-wind directions (NNE, ENE, ESE, SSE, SSW, WSW, WNW, NNW). The 10 concentric distance circles were then combined with the 16 directional sectors to create a circular grid with 160 sections (Figure 2.2 through Figure 2.6).

Table 2.1 Locations of Hanford Site Operating Areas

Operating Area	Longitude	Latitude	State Plane X (meters)	State Plane Y (meters)
100K	-119.5985	46.6481	569006	146530.6
200W	-119.6323	46.5539	566534	136031.6
200E (WTP)	-119.5058	46.5516	576236.6	135890.4
300	-119.2750	46.3685	594249.5	115790.1
400	-119.3624	46.4352	587418.6	123102.3

In order to determine the population totals for each circular grid section, Census 2020 Tiger/Line block-level shapefiles containing Census 2020 Redistricting population totals (Census 2020a, 2020b) were brought into R via Census API accessing package tidycensus and tigris (Walker 2022, Walker and Herman 2022). The area was calculated for each block and the population was assumed to be evenly distributed within that area. Then the block-level boundaries were intersected with the circular grids. The area was again calculated for the newly intersected blocks. To calculate a new population for each of the 160 grid segments, the areas for the block portions within a grid were multiplied by their respective original average census block population densities, then summed and rounded to the nearest whole number. For example, if a circular grid section contained 40% of the original area of a block, then it was assumed that the section also contained 40% of the block’s original population. This procedure was repeated for grids centered at each location of interest to create the 50-mile (80-km) population distribution based on the 2020 Census data. See Figure 2.2 through Figure 2.6 for census block overlays with the 50-mile radial grid. All circular grids, census blocks, and site centroids were projected to NAD83 Washington State Plane South (EPSG:32149) prior to analysis.

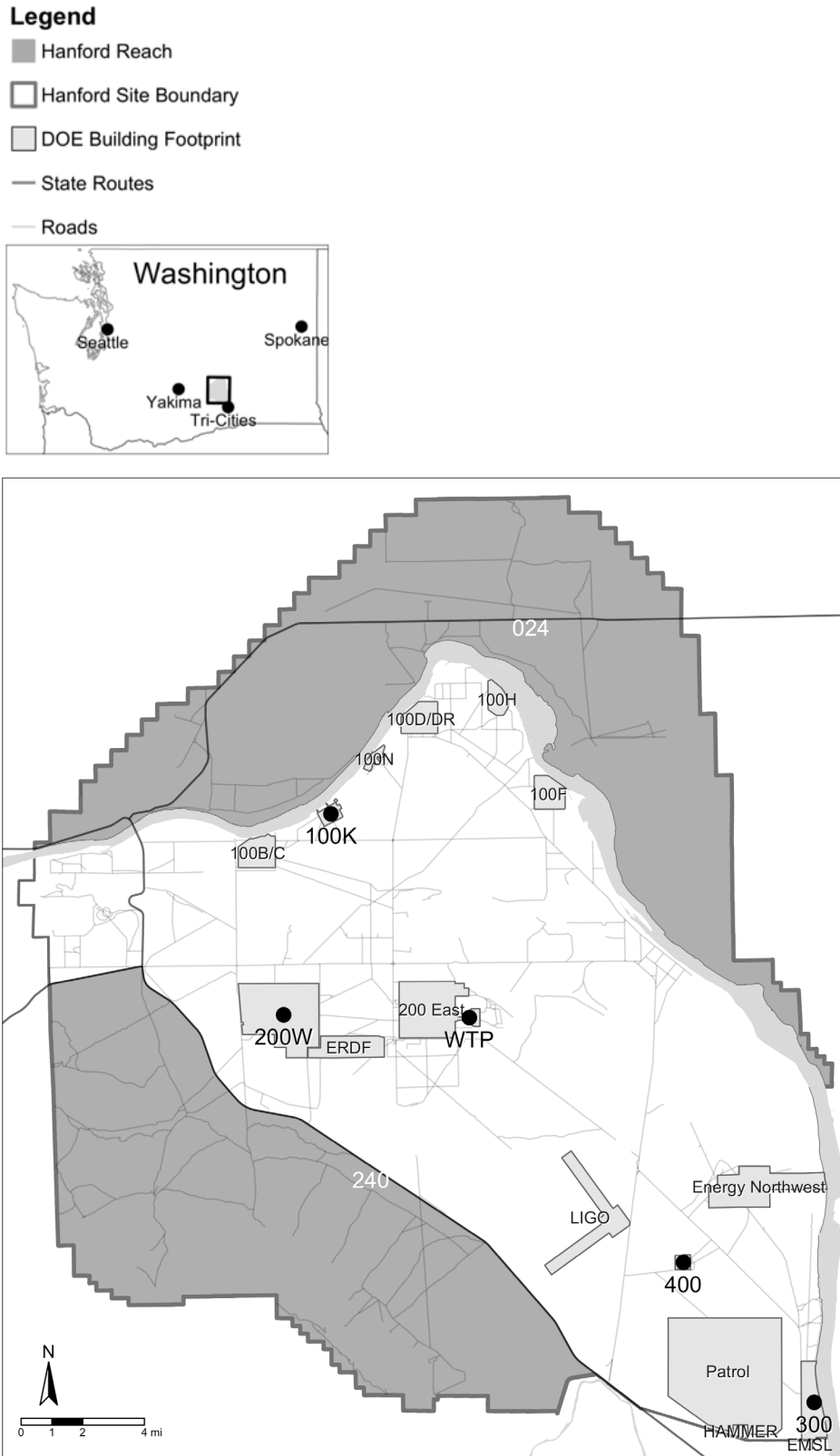


Figure 2.1. Centroid Locations for 50-mile Population Distributions

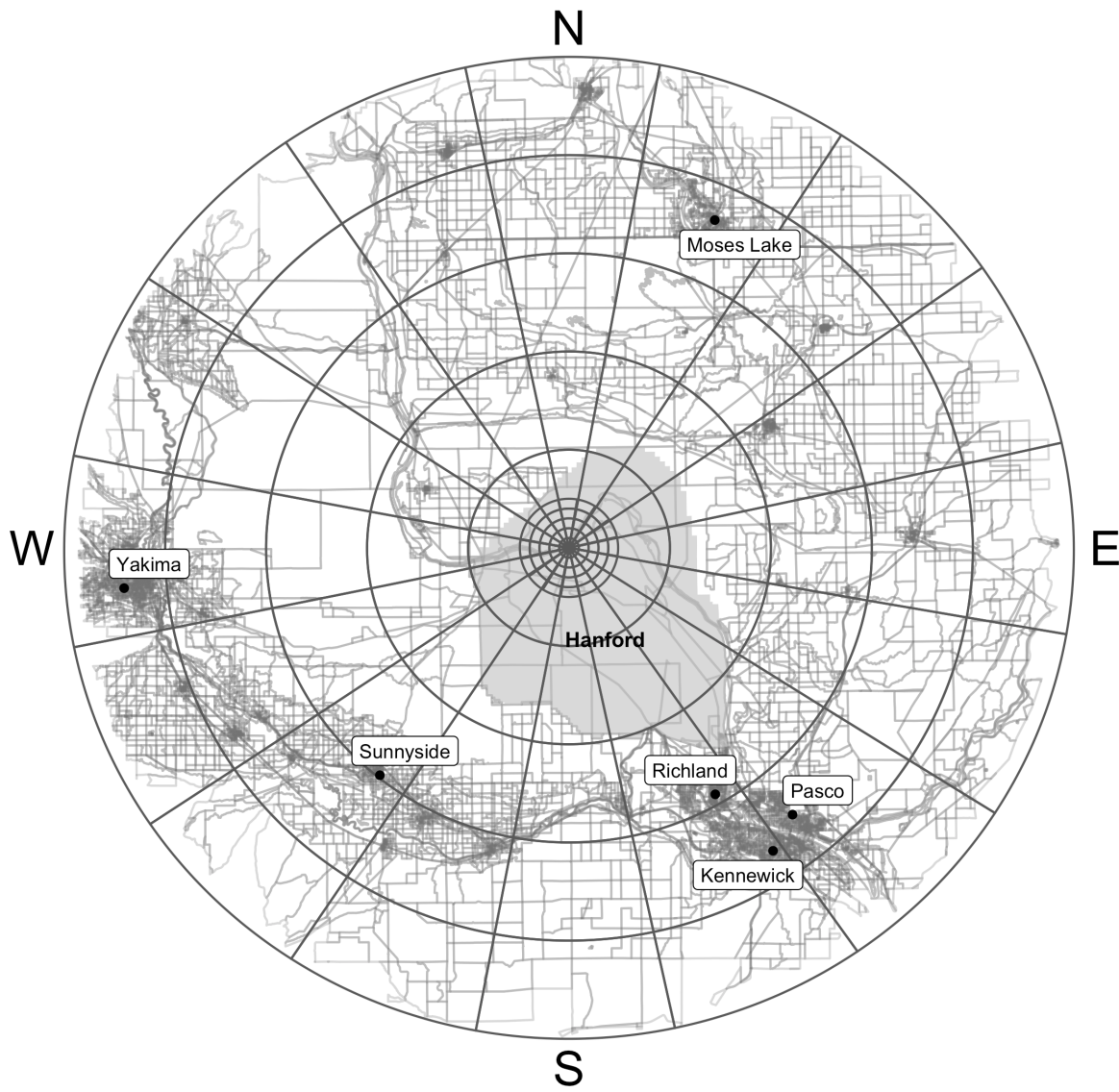


Figure 2.2. 100K Centroid 50-mile Region and Census Block Overlay

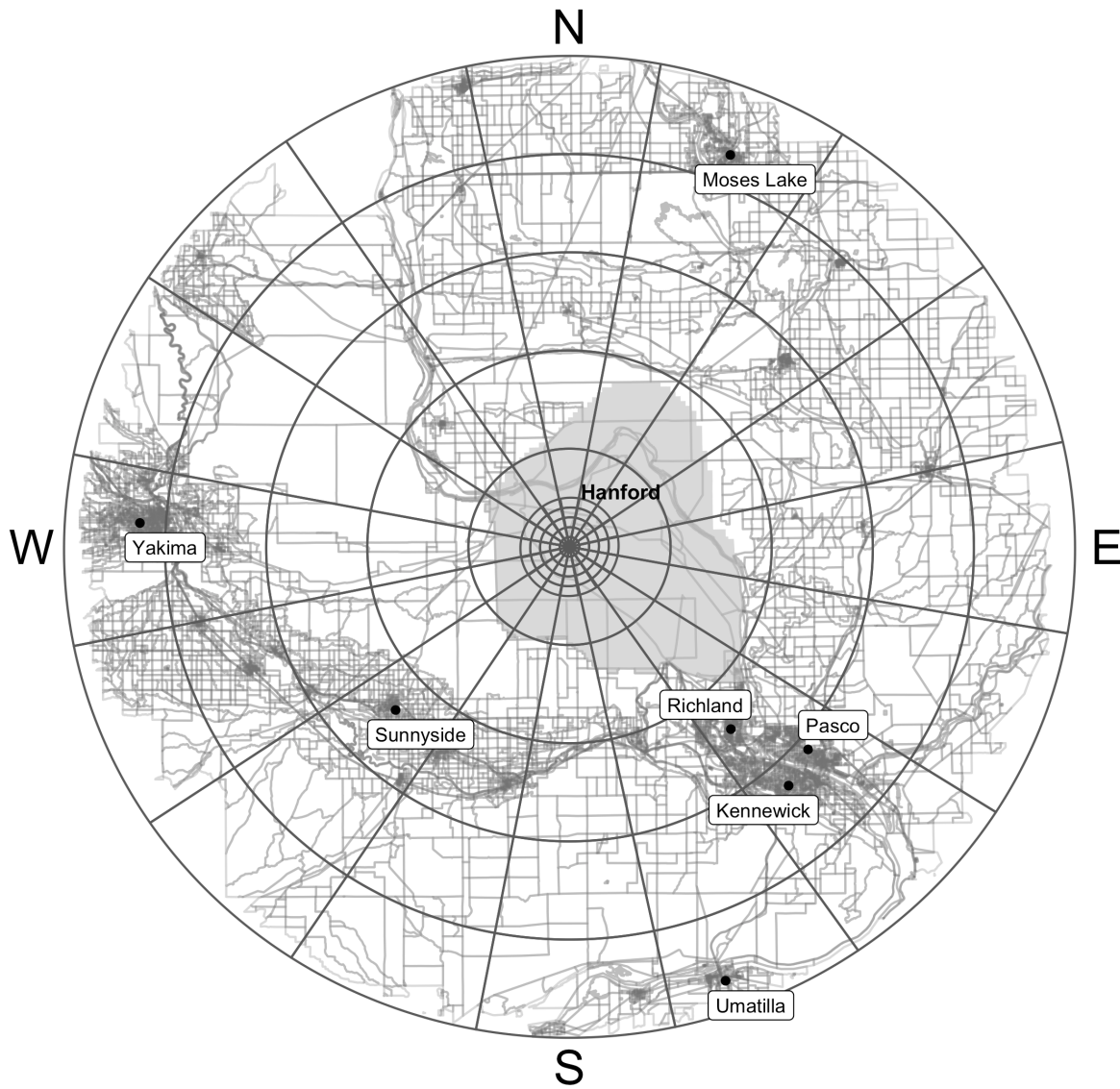


Figure 2.3. 200W Centroid 50-mile Region and Census Block Overlay

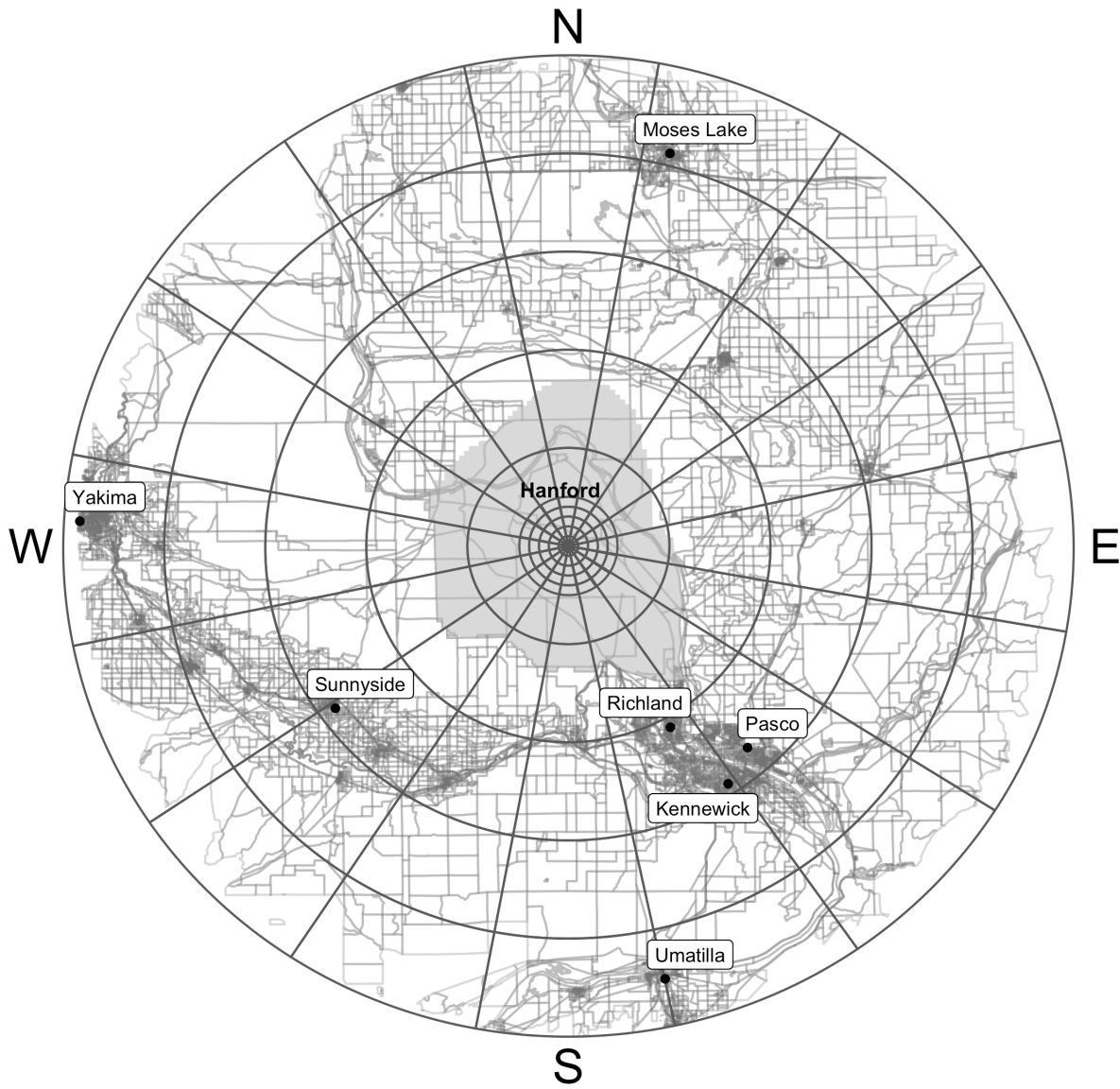


Figure 2.4. 200E (WTP) Centroid 50-mile Region and Census Block Overlay

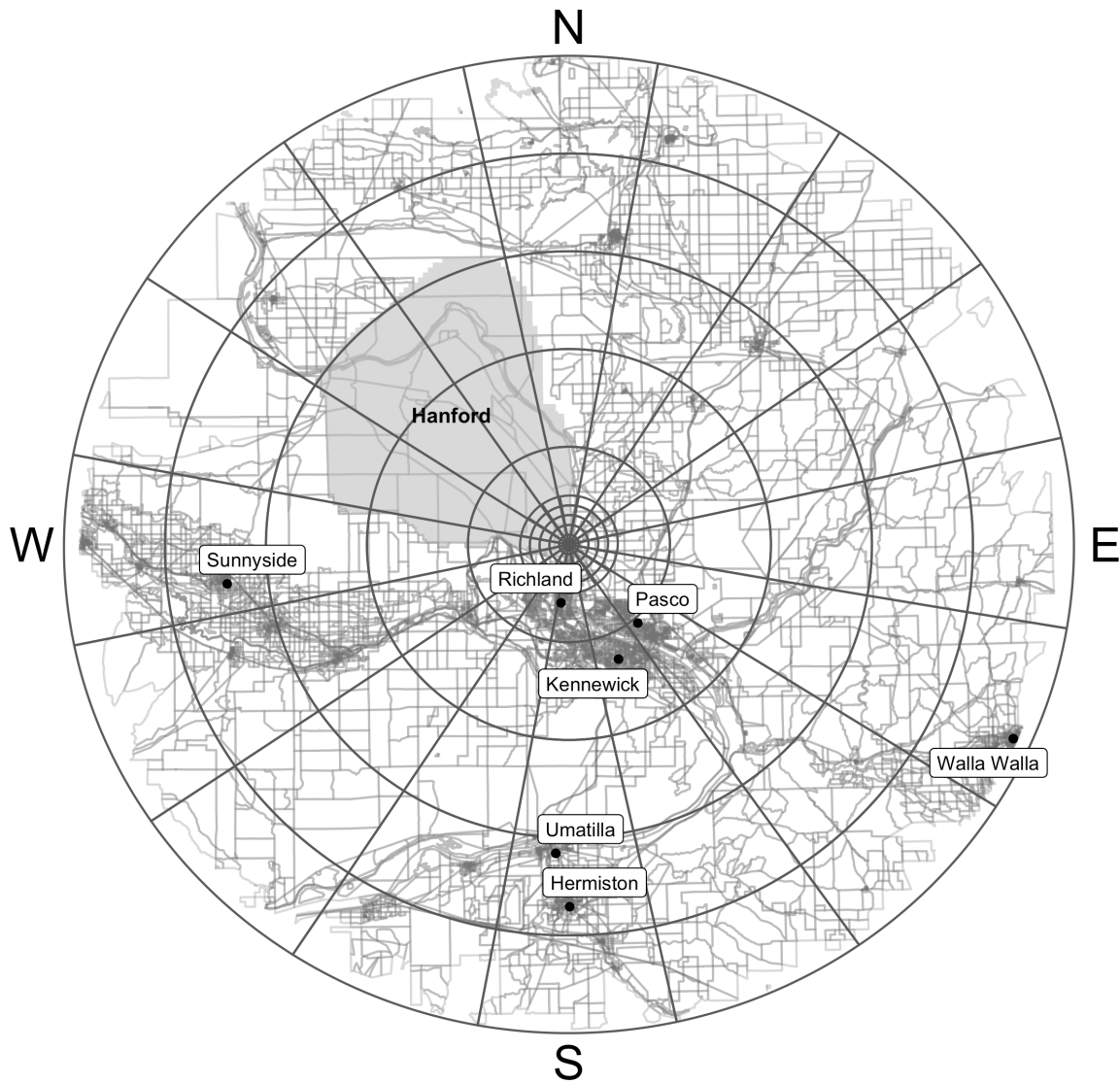


Figure 2.5. 300 Area Centroid 50-mile Region and Census Block Overlay

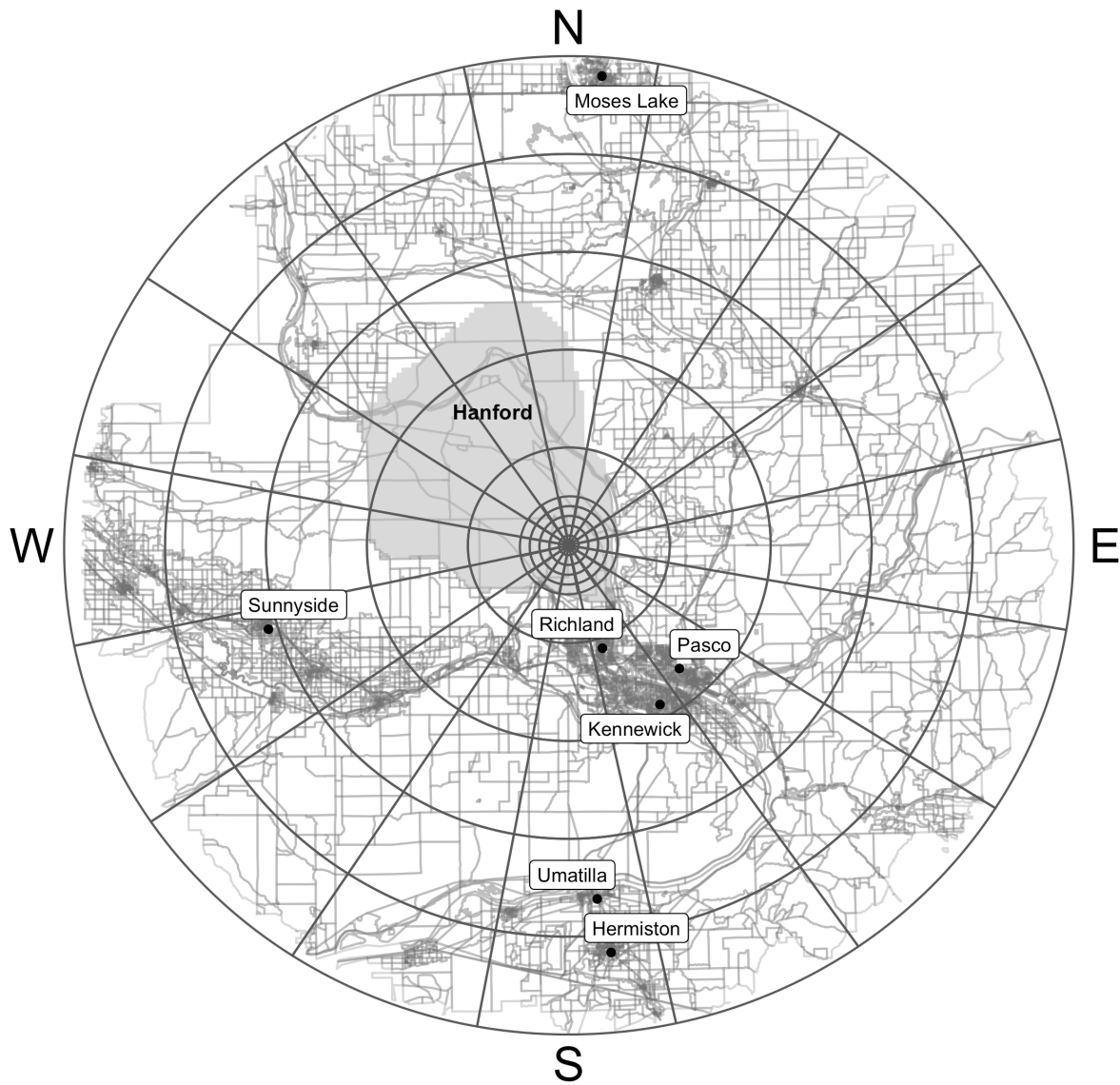


Figure 2.6. 400 Area Centroid 50-mile Region and Census Block Overlay

3.0 Data Graphics and Tables

The data resulting from the evaluation described in Section 2.0 are presented here in graphic and tabular forms. The user can then format the population distributions as needed for a particular application. Figure 3.1 through Figure 3.5 indicate the 5-10 mile and additional 10 mile-increment populations in the larger grid, and the 1-mile increment populations in the smaller 0-5 mile inset. Grid directions follow the compass rose with the top center sectors as North. Table 3.1 through Table 3.5 present the data in tabular form.

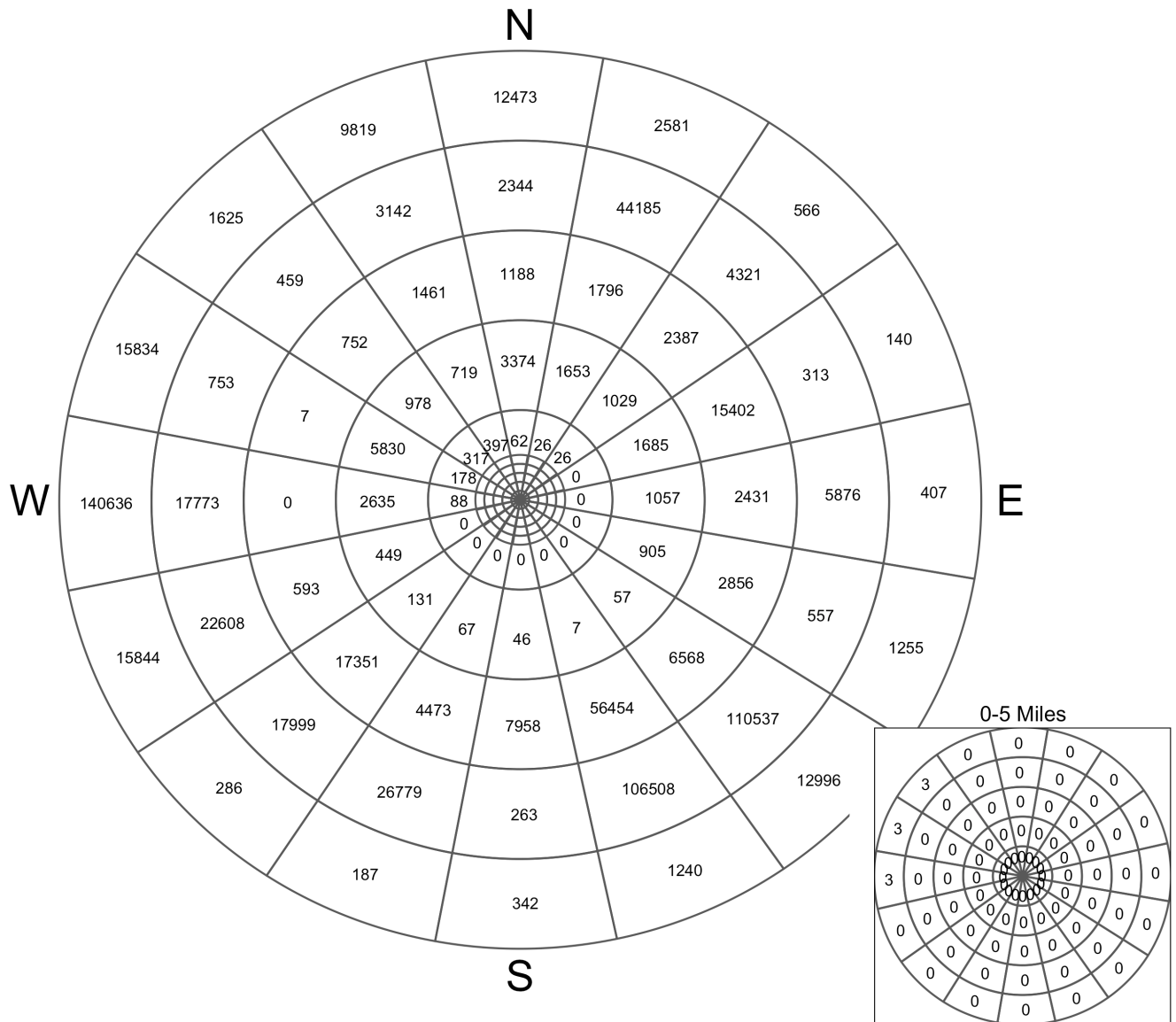


Figure 3.1. 100K 50-mile Population

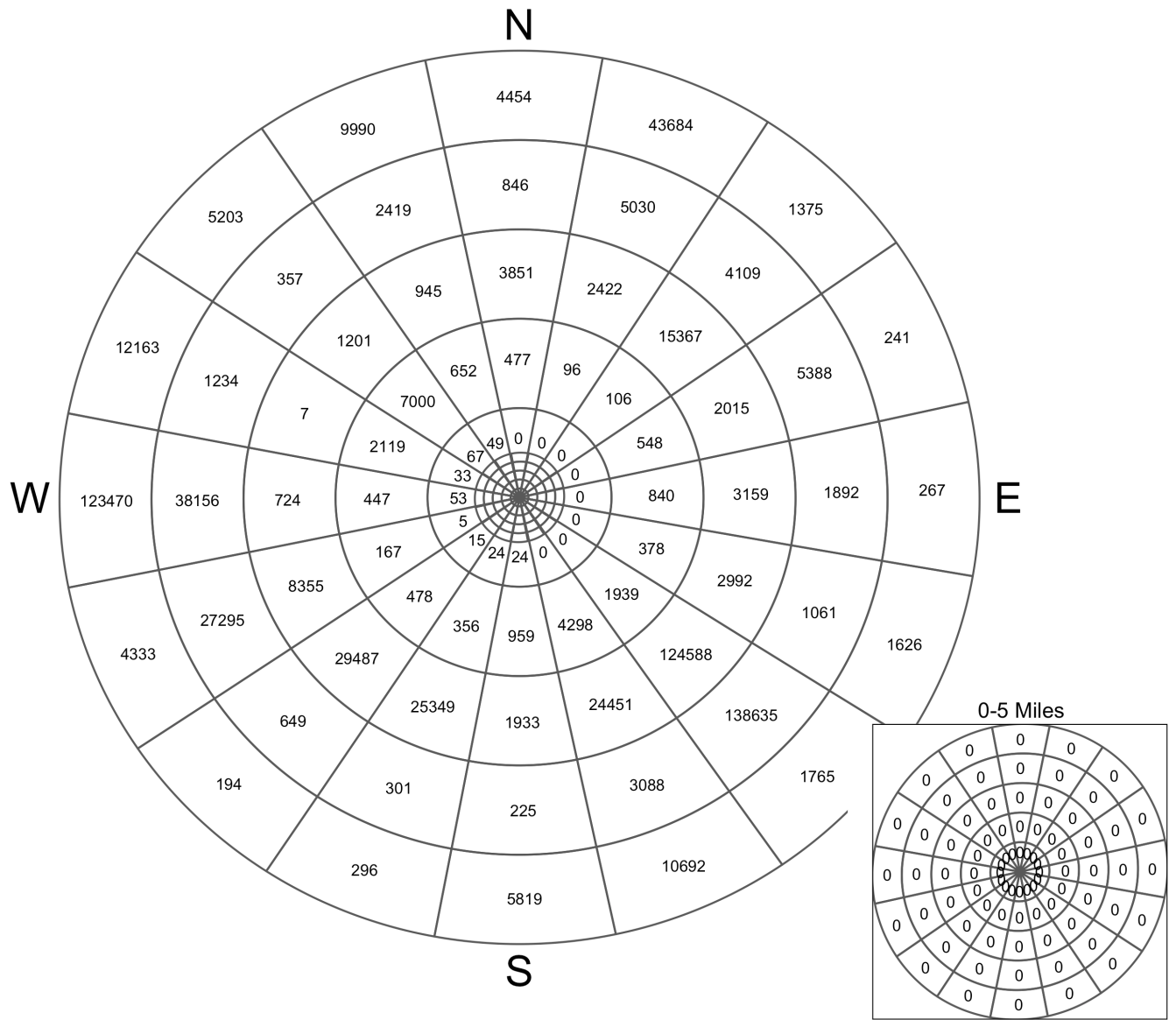


Figure 3.2. 200W 50-mile Population

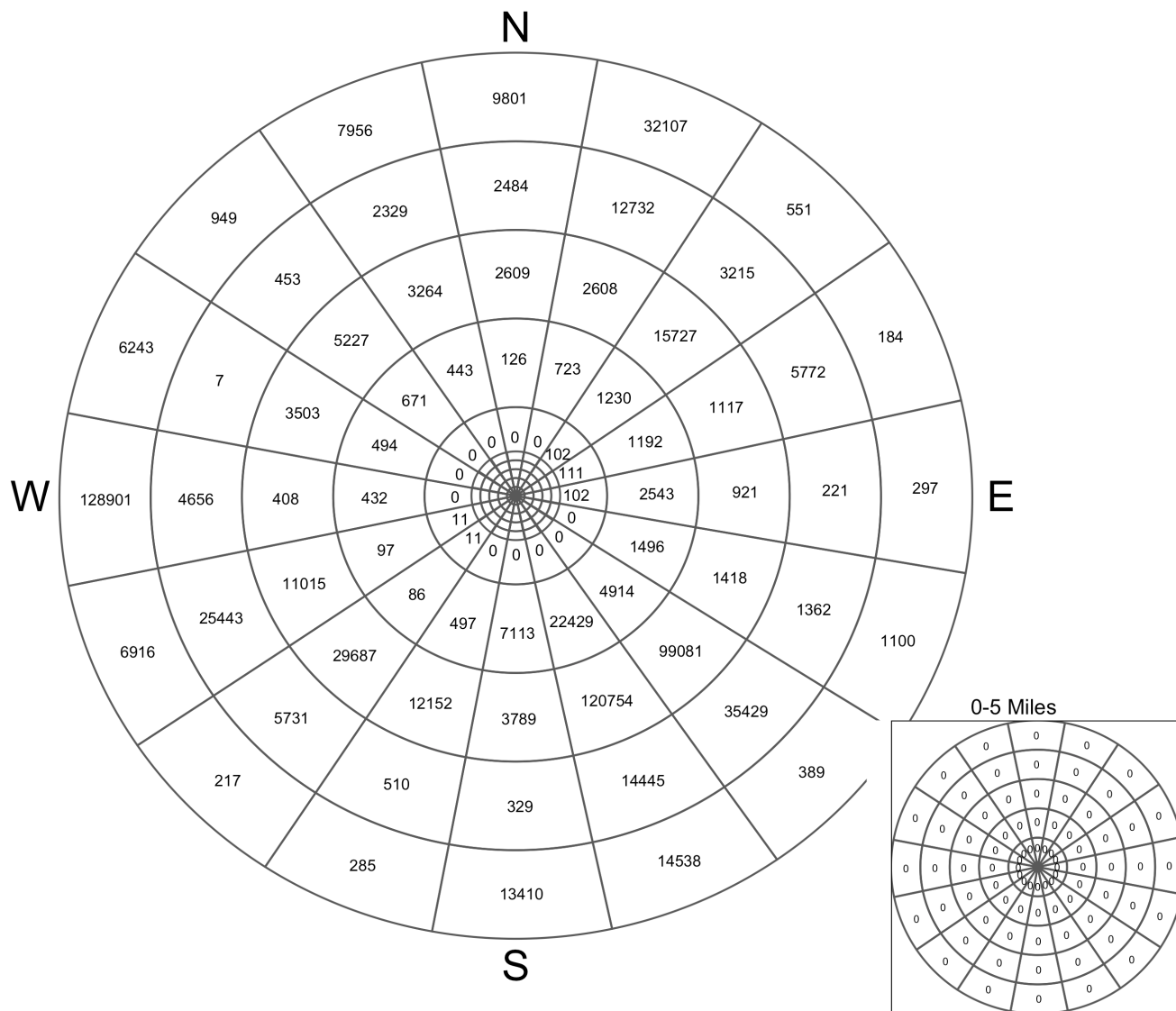
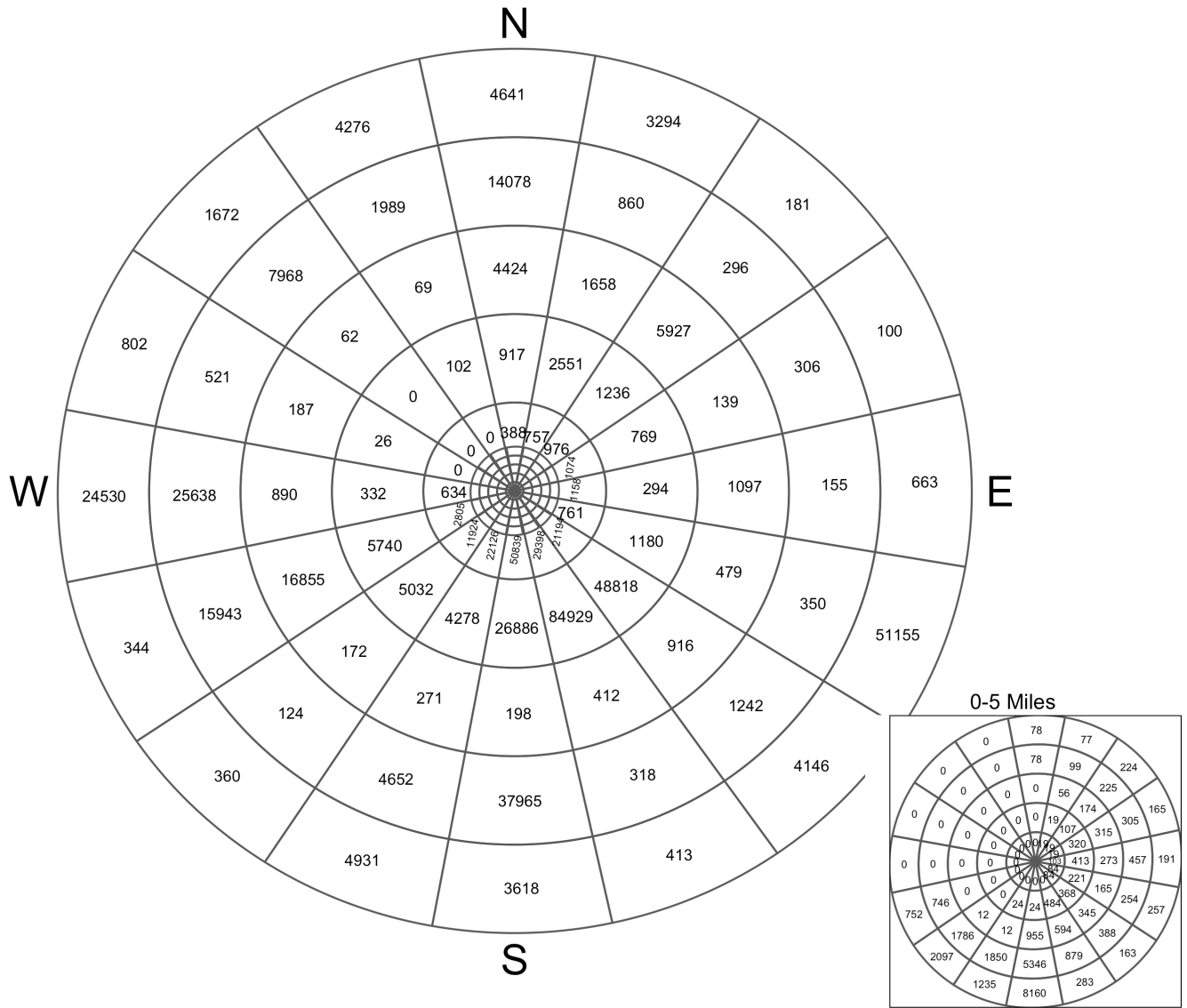


Figure 3.3. 200E (WTP) 50-mile Population



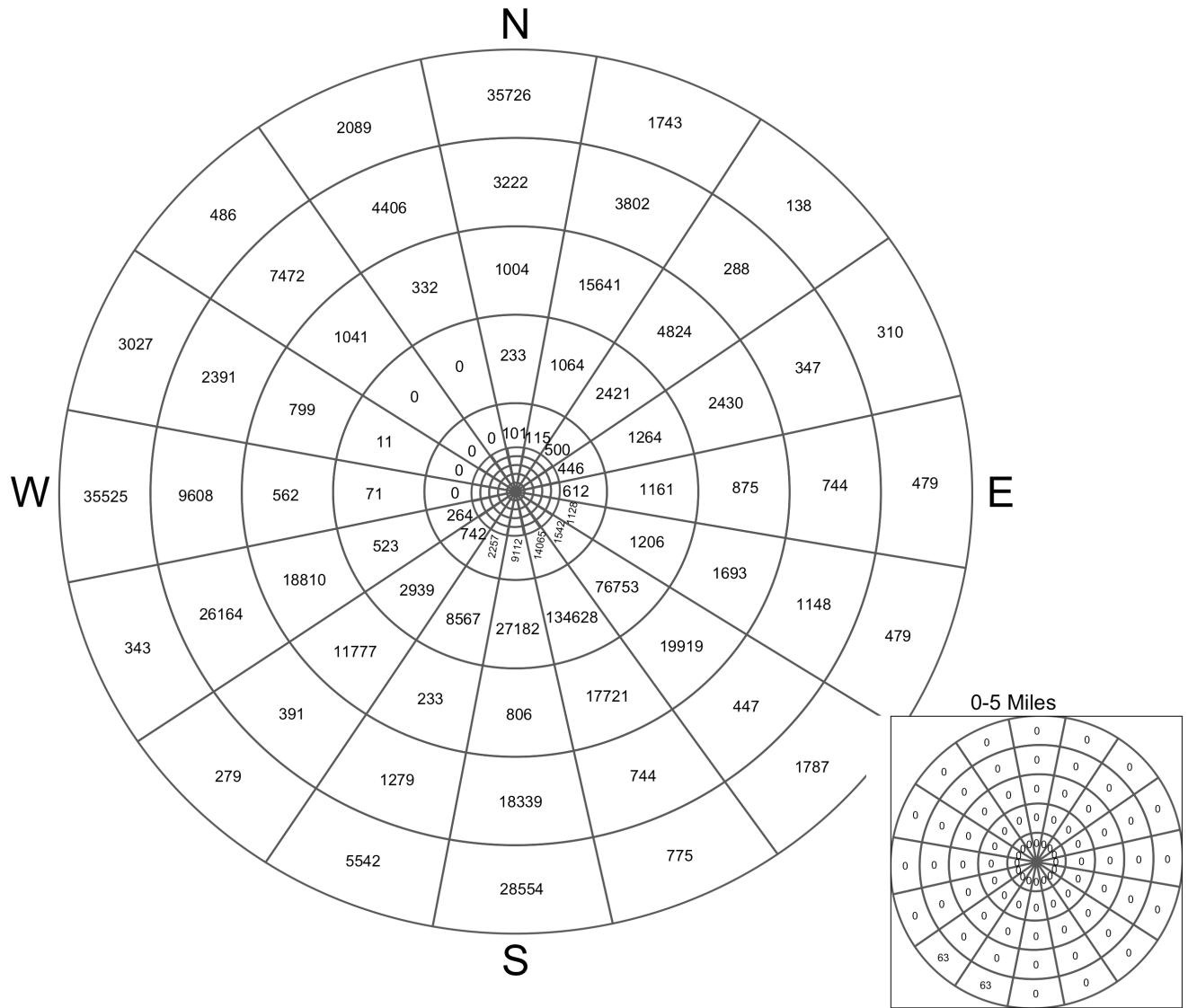


Figure 3.5. 400 Area 50-mile Population

Table 3.1 100K 50-mile Population

Distance (mi)	Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-5	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	0
5-10	62	26	26	0	0	0	0	0	0	0	0	0	88	178	317	397	1094
10-20	3374	1653	1029	1685	1057	905	57	7	46	67	131	449	2635	5830	978	719	20622
20-30	1188	1796	2387	15402	2431	2856	6568	56454	7958	4473	17351	593	0	7	752	1461	121677
30-40	2344	44185	4321	313	5876	557	110537	106508	263	26779	17999	22608	17773	753	459	3142	364417
40-50	12473	2581	566	140	407	1255	12996	1240	342	187	286	15844	140636	15834	1625	9819	216231
Total	19441	50241	8329	17540	9771	5573	130158	164209	8609	31506	35767	39494	161135	22605	4134	15538	724050

Table 3.2 200W 50-mile Population

Distance (mi)	Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-10	0	0	0	0	0	0	0	0	24	24	15	5	53	33	67	49	270
10-20	477	96	106	548	840	378	1939	4298	959	356	478	167	447	2119	7000	652	20860
20-30	3851	2422	15367	2015	3159	2992	124588	24451	1933	25349	29487	8355	724	7	1201	945	246846
30-40	846	5030	4109	5388	1892	1061	138635	3088	225	301	649	27295	38156	1234	357	2419	230685
40-50	4454	43684	1375	241	267	1626	1765	10692	5819	296	194	4333	123470	12163	5203	9990	225572
Total	9628	51232	20957	8192	6158	6057	266927	42529	8960	26326	30823	40155	162850	15556	13828	14055	724233

Table 3.3 200E (WTP) 50-mile Population

Distance (mi)	Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-10	0	0	102	111	102	0	0	0	0	0	11	11	0	0	0	0	337
10-20	126	723	1230	1192	2543	1496	4914	22429	7113	497	86	97	432	494	671	443	44486
20-30	2609	2608	15727	1117	921	1418	99081	120754	3789	12152	29687	11015	408	3503	5227	3264	313280
30-40	2484	12732	3215	5772	221	1362	35429	14445	329	510	5731	25443	4656	7	453	2329	115118
40-50	9801	32107	551	184	297	1100	389	14538	13410	285	217	6916	128901	6243	949	7956	223844
Total	15020	48170	20825	8376	4084	5376	139813	172166	24641	13444	35732	43482	134397	10247	7300	13992	697065

Table 3.4 300 Area 50-mile Population

Distance (mi)	Direction																
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1	0	19	19	19	103	84	84	0	0	0	0	0	0	0	0	0	328
1-2	0	19	107	320	413	221	368	484	24	24	0	0	0	0	0	0	1980
2-3	0	56	174	315	273	165	345	594	955	12	12	0	0	0	0	0	2901
3-4	78	99	225	305	457	254	388	879	5346	1850	1786	746	0	0	0	0	12413
4-5	78	77	224	165	191	257	163	283	8160	1235	2097	752	0	0	0	0	13682
5-10	388	757	976	1074	1158	761	21194	29398	50839	22126	11924	2805	634	0	0	0	144034
10-20	917	2551	1236	769	294	1180	48818	84929	26886	4278	5032	5740	332	26	0	102	183090
20-30	4424	1658	5927	139	1097	479	916	412	198	271	172	16855	890	187	62	69	33756
30-40	14078	860	296	306	155	350	1242	318	37965	4652	124	15943	25638	521	7968	1989	112405
40-50	4641	3294	181	100	663	51155	4146	413	3618	4931	360	344	24530	802	1672	4276	105126
Total	24604	9390	9365	3512	4804	54906	77664	117710	133991	39379	21507	43185	52024	1536	9702	6436	609715

Table 3.5 400 Area 50-mile Population

Distance (mi)	Direction															Total	
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW		NNW
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-5	0	0	0	0	0	0	0	0	0	63	63	0	0	0	0	0	0
5-10	101	115	500	446	612	1128	1542	14065	9112	2257	742	264	0	0	0	0	30884
10-20	233	1064	2421	1264	1161	1206	76753	134628	27182	8567	2939	523	71	11	0	0	258023
20-30	1004	15641	4824	2430	875	1693	19919	17721	806	233	11777	18810	562	799	1041	332	98467
30-40	3222	3802	288	347	744	1148	447	744	18339	1279	391	26164	9608	2391	7472	4406	80792
40-50	35726	1743	138	310	479	479	1787	775	28554	5542	279	343	35525	3027	486	2089	117282
Total	40286	22365	8171	4797	3871	5654	100448	167933	83993	17941	16191	46104	45766	6228	8999	6827	585574

4.0 Notes on Data Use

The data presented in this report strictly follow the evaluation procedure described, and no additional verification has been performed. The process of averaging populations over the census block area may indicate the presence of a residential individual where none exists, or no individuals where one does exist. In addition, census data may not be complete for some census blocks due to collection issues within the U.S. Census. These are important factors to consider, especially for dose calculations at distances in closer proximity to an emission source.

5.0 Summary of Population Data

The 50-mile populations have been evaluated from 1990 (Beck et al. 1991), 2000 (Elliott et al. 2004), 2010 (Hamilton and Snyder 2011), and the current 2020 U.S. Census data. Table 5.1 summarizes these total population data for the operational areas evaluated. The operational areas evaluated changed over time to reflect the locations of major radiological activities. As indicated in the table, the population change continues an upward trend and has remained rather stable (about 20-30%) over each decade. However, the 2020 analysis revealed the largest percent change (41%) for the 300 Area 50-mile population, largely due to Tri-Cities area (Richland, Kennewick, Pasco, plus West Richland) and Walla Walla population increases.

Table 5.1 50-mile Populations – 1990, 2000, 2010, and 2020 Census

Hanford Site Centroid	1990 Census	2000 Census	2010 Census	2020 Census	Year 2010 to 2020 Change	
100F	303,022	382,206	N/A	N/A	N/A	
100K	N/A	481,857	580,572	724,050	25%	increase
100N	375,249	N/A	N/A	N/A	N/A	
200HMS	375,860	486,294	586,500	N/A	N/A	
200W (PFP)	381,936	N/A	N/A	N/A	N/A	
200W (central)	N/A	N/A	N/A	724,233	N/A ^(a)	
200E (WTP)	N/A	N/A	553,516	697,065	26%	increase
300 Area	281,586	349,067	432,117	609,715	41%	increase
400 Area	283,228	353,712	442,745	585,574	32%	increase

(a) A 23% increase from the 2010 Census 200HMS value.

HMS= Hanford Meteorological Station, PFP= Plutonium Finishing Plant, WTP= Waste Treatment Plant

A principal use of this population data is for the determination of offsite collective dose from radioactive material emissions in air effluent. In general, receptors closer to an air emission point will incur a greater collective dose. Data tabulated in Section 3 indicate that the 300 Area centroid has the largest number of receptors within 5 miles (31,304) compared to other centroids (i.e., 100K [9], 200W [0], WTP [0], 400 [126]).

Figures 5.1 and 5.2 illustrate the trends of Hanford-area cities in Washington by Census population (Figure 5.1) and percent change between Census counts (Figure 5.2).

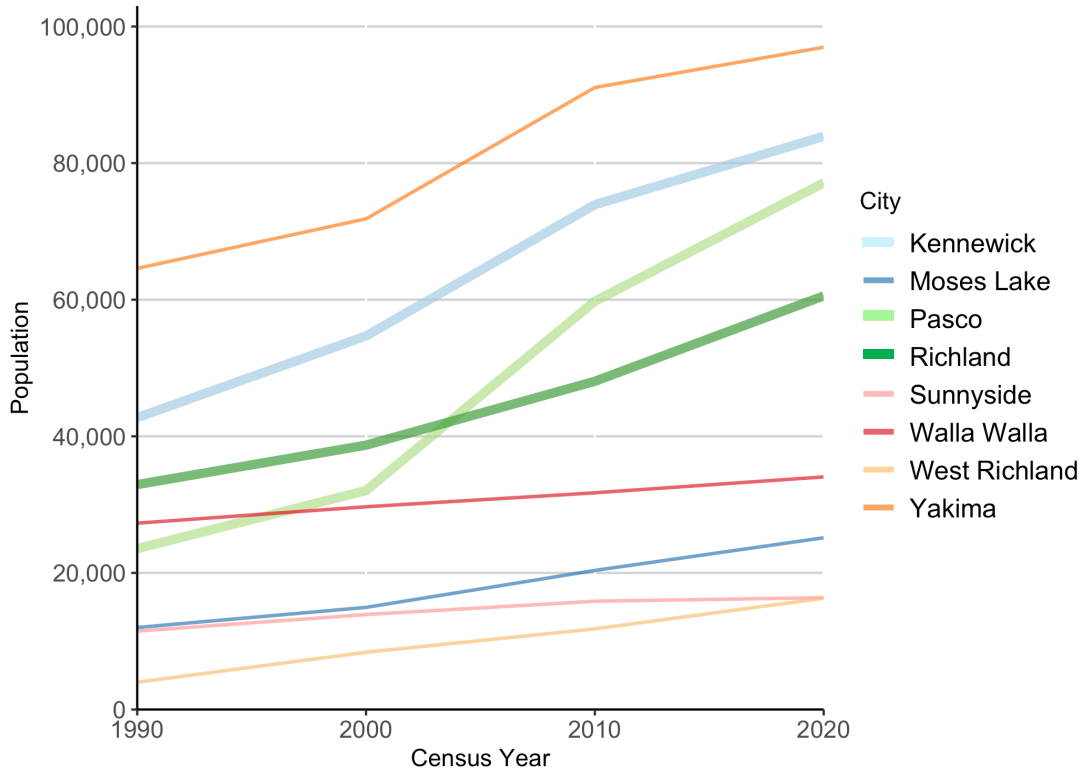


Figure 5.1 Hanford Area City Census Trends – Population

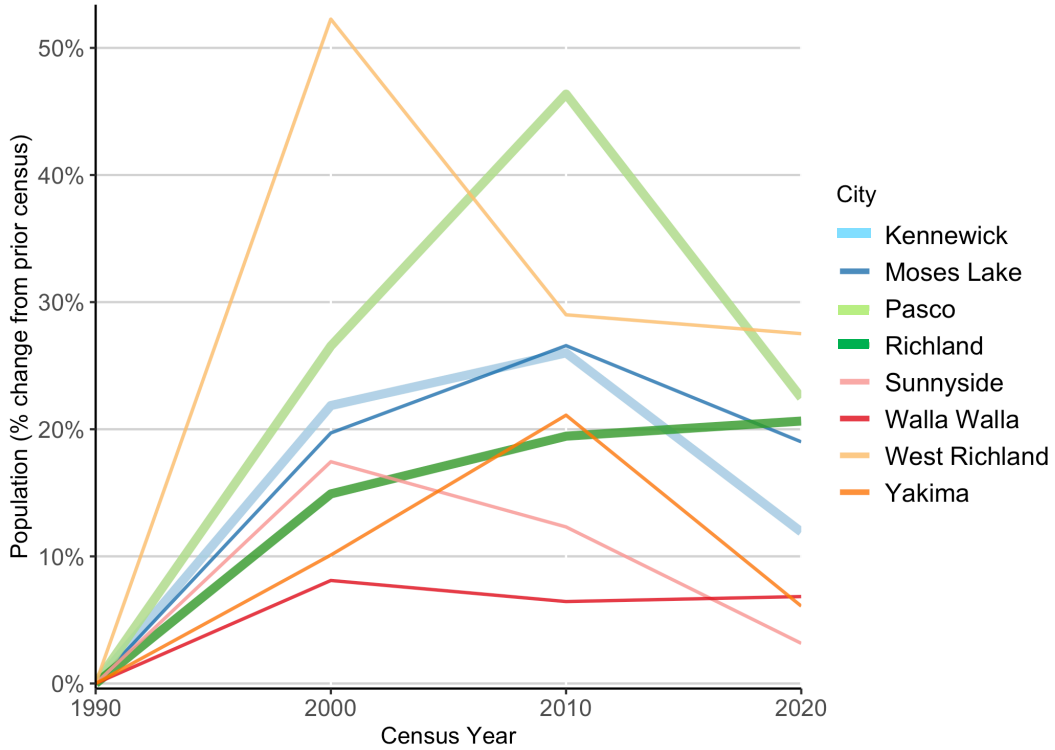


Figure 5.2 Hanford Area City Census Trends – Percent Change

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