Office for Nuclear Regulation

ONR Guidance Document

Land Use Planning and The Siting of Nuclear Installations

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Authored by: Inspector

Approved by: DL – EP&R

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Table 1 - Revision Commentary

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	Minor revision: • Updated to latest 'guidance document' format; • Review date extended by one year on the basis that guidance is for a work package that is not scheduled to occur again until 2024, and BEIS are currently considering changes that may impact the content of this document.

Contents

1. Introduction

Since the start of the civil nuclear power programme in the 1960s, the government has applied a policy of siting new nuclear power plants in areas where the population density does not exceed certain thresholds, and where the growth of that population can be monitored and controlled.

The application of exclusionary demographic criteria during site selection is independent of the detailed safety assessment that is undertaken by ONR prior to the decision to grant (or withhold) a nuclear site licence (although confirmation that the demographic criteria continue to be met is sought as part of this assessment). The detailed safety assessment is informed by ONR's Safety Assessment Principles (SAPs), together with supporting Technical Assessment Guides (TAGs), which consider the provision of defence in depth to prevent and control fault conditions and to mitigate the consequences in the event that a radiological release occurs. Constraints on the distribution of population around nuclear power plants provide additional public protection against the remote possibility that the multiple defence in depth provisions should fail, by limiting the number of persons who may be affected by such a release and who would require protection via the implementation of countermeasures identified within the off-site emergency planning arrangements.

First generation civil nuclear power stations in the UK were sited in areas that were situated far away from major population centres (i.e. in accordance with "remote" demographic siting criteria). Later, second generation nuclear power stations were permitted to be sited closer to major population centres. The criteria applied are termed the "semi-urban" demographic siting criteria and are derived so that there is no single 30° sector around the site in which the population density exceeds 5000 persons per square kilometre and the population density all around the site is substantially less than this. The Government has retained and restated the semi-urban demographic siting criteria as being applicable to all third generation nuclear power stations that may be constructed within England and Wales.

This guide sets out ONR's use of demographic criteria when considering: the strategic assessment of potentially suitable sites; the licensing of new nuclear power plant sites; the subsequent control of future development around such sites; and the periodic review of the distribution of population around them. It also consolidates and clarifies ONR's position on the interpretation and application of the semi-urban demographic criteria, and provides a number of illustrative examples. It is primarily intended for use by ONR inspectors but it provides details of the numerical methodology used by ONR, which may be of interest to a wider technical audience.

1.1. Purpose and Scope

This guide describes ONR's current approach to the assessment of demographics during site selection and licensing. It also describes the administrative arrangements in place to ensure that the demographic basis for the licensing of nuclear power station sites is preserved and that the population distribution in the vicinity of all nuclear sites does not reach levels that may threaten the viability, operability or extendibility of off-site arrangements for dealing with potential radiation emergencies. Technical details of the

basis for the demographics assessment are given in Section 5 and worked examples are given in Sections 6 and 7.

This guide also clarifies and confirms that the semi-urban demographic siting criteria will not be used as exclusionary criteria for the potential siting of proposed nuclear installations that are not nuclear power stations.

This guide revises and replaces previous guidance [1] produced by the Nuclear Directorate of the Health and Safety Executive in 2009.

2. Development of Demographic Siting Criteria

First generation Magnox power stations were located in sites meeting "remote site" demographic criteria defined in terms of 10° sector limits (for population within radial distances of 1/3, 1½, 5 and 10 miles) with a site limit equal to 6 times the 10° sector limits [2]. These criteria were later revised and restated as 30° sector limits (in incremental bands of 1 mile intervals out to 20 miles) [3].

In 1968, the then Minister of Power, announced that second generation Advanced Gas-cooled Reactors (AGRs) could be built on sites where the local population distribution exceeded the "remote site" criteria applied to the earlier Magnox power station sites [4]. Initially no quantitative criteria were specified for AGR sites – the qualitative constraint was that, in response to any release that should warrant such action, the population within a few kilometres of the site in any 30° sector should be limited so that evacuation of any affected sector would be achievable within two hours.

However, it was thought desirable by the then Inspectorate of Nuclear Installations (INI) [5] to have some quantitative demographic siting criteria which specified acceptable population distributions, to provide:

• a guide to prospective licensees in the examination of potential sites (to prevent prospective licensees from expending resources on the development of proposed sites that would not be licensable due to demographic considerations);

• a measurable standard against which alternative sites could be assessed; and

• a mechanism for the subsequent control of residential developments around an approved site, to prevent population levels proximal to a site rising to undesirable levels.

Charlesworth and Gronow [6] developed a methodology that allowed the comparison of the demographics around potential reactor sites by deriving population weighting factors for a series of radial distance bands out to 20 miles. These weighting factors were derived from the atmospheric dispersion of a hypothetical release of radioiodine and represent the average doses to the thyroid that a standard person would receive in each radial band, if no protective measures were implemented. These weighting factors were then applied to the population distribution around the sites to determine site and (30°) sector risk factors, derived from the collective thyroid dose. Limiting site and 30° sector risk factors were then determined [7], which were approximately 1/10th of the risk factors evaluated for a fully urban site, and also bounded the risk factors for the Heysham site (with projected population increases due to future development having been taken into account).

A graphical presentation of the results for the site risk factors is shown in Figure 1 below. The dashed curve corresponds to the limiting risk factor for AGR sites and the curve labelled "Site 6" represents an urban site.
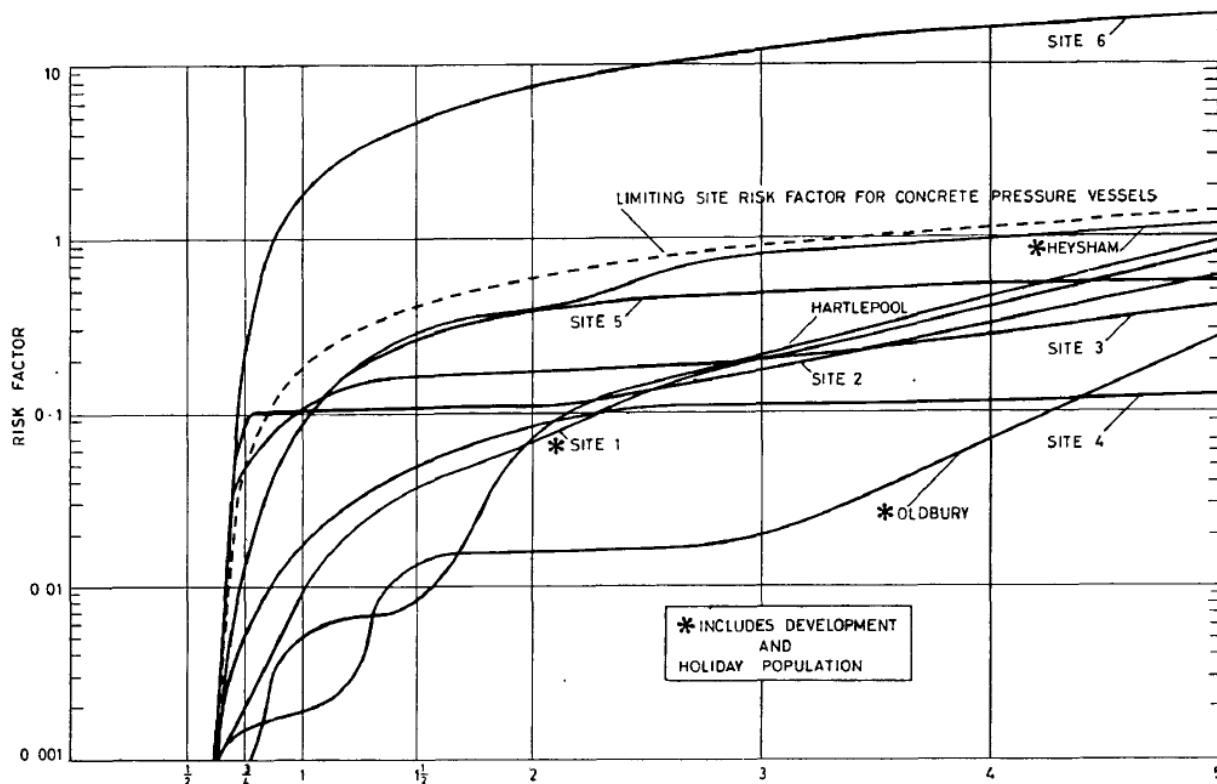
Figure 1: Comparative evaluation of site risk characteristics (from Ref. 7)

The limiting sector risk factors were equivalent to a uniform population density of ~ 5000 persons per square kilometre out from 0.67 to 20 miles from the site. The limiting site risk factors correspond to site uniform population densities that range from 1050 - 790 persons per square kilometre (decreasing as the radial distances increase).

In March 1988, the then Secretary of State for Energy tabled demographic criteria (in Parliament and thus referred to as the semi-urban Hansard 1988 criteria) for assessing potential sites, both for Magnox reactors and AGRs [8]. These were presented as cumulative weighted population values for 30° sector and all around the site, in bands of increasing radii out to 30 km. These were consistent with the previous criteria, subject to some slight variations arising from the conversion from imperial to metric units. Comparison of the range of limiting population densities and limiting populations, where uniform population distributions have been assumed, shows that the semi-urban INI and semi-urban Hansard 1988 criteria are consistent with one another.

In the Government's 2008 Strategic Siting Assessment (SSA) [9], the AGR (semi-urban) criteria, were adopted as exclusionary criteria for "the future siting of international modern designs". These criteria are also proposed as the exclusionary criteria to be applied to reactor sites to be developed beyond 2025 in the recent BEIS Consultation [10].

ONR reviewed its own demographic criteria as part of the 2008 SSA process and the output of this review was a discussion paper presented to our independent Nuclear Safety Advisory Committee (NuSAC), titled "The Siting of Nuclear Installations in the United Kingdom" [11]. This paper introduced a revised methodology for the assessment of demographics based on the comparison of sites against a hypothetical site with a uniform

distribution of population. The cumulative weighted population values for each 30° sector (from θ= 0° to θ = 355°, in 5° increments) and all around the site (0° to 360°), in 1 km increments from 0-2 km to 0-30 km were divided by the equivalent values for the hypothetical site with uniform population densities at the semi-urban population density limit (with a notional exclusion zone from 0-1 km from site) to generate a matrix of Site Population Factors (72 x 29 sector SPFs and 29 all around the site SPFs). The methodology allows the conditions for meeting all the semi-urban criteria to be succinctly expressed as a single criterion:

$$SPF_{MAX} < 1$$

The paper also proposed that:

- the 30° sector cumulative weighted population values should be derived using a semi-urban population density limit of 5000 persons per square kilometre;

- the all around site cumulative weighted population values should be derived using a semi-urban population density limit of 1250 persons per square kilometre); and

- these semi-urban criteria should be applied as exclusionary criteria for the siting of all new nuclear installations within the UK.

This revised methodology was adopted by the then Nuclear Directorate of HSE in 2009 and presented in Ref. 1. However, review work undertaken in support of the BEIS 2017 Consultation [10] highlighted that the guidance does not provide a clear statement of the exclusionary criteria to be applied to new nuclear power station sites nor confirmation of whether such criteria would be applied to other nuclear facilities. It was also noted that the site uniform density constraint of 1,250 persons per square kilometre, proposed in the NuSAC paper differs from the limiting criteria applied to the siting of the AGR stations.

These issues are addressed via the revised ONR criteria described in Section 3 below.

3. Application of the "Semi-Urban" Demographic Siting Criteria

The following demographic criteria will be used by ONR in determining the potential suitability of sites for the deployment of new nuclear power stations during both the site selection and site licensing processes:

- the cumulative weighted population values for any 30° sector in the ranges $0 - R_i$ (where R_i is a circle of radius i km and i varies from 2 to 30 km) shall not exceed those for a hypothetical 30° sector with a uniform population density of 5000 persons per km^2 from 1 to 30 km and zero population within 1 km[1].; and

- the cumulative weighted population values all around the site in the ranges $0 - R_i$ (where R_i is a circle of radius i km and i varies in 1 km increments from 2 to 30 km) shall not exceed those for a hypothetical circle with a uniform population density of 1000 persons per km^2 from 1 to 30 km with zero population within 1 km;

- where the weighting factors applied to the population within each radial band shall be proportional to $1/R^{1.5}$ and R is the area-weighted average distance between the radial band and the site centre point.

A site shall be determined to be potentially suitable for the deployment of new nuclear power stations if all the ratios of the actual versus the hypothetical cumulative weighted population values ("Site Population Factors") are less than unity, i.e.

$$SPF_{MAX} < 1$$

These semi-urban demographic siting criteria will only used as exclusionary criteria for the potential siting of proposed nuclear power stations. They will not be used in siting considerations for other types of nuclear installations. For these installations, the suitability of the site will be considered during ONR's detailed safety assessment undertaken during the site licensing process [12] against the requirement that the location must be suitable for the establishing an adequate emergency plan in accordance with the licence conditions and the Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR).

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[1] When considering actual sites, it is recognised that there may be some residential dwellings within the $0 - 1$ km zone. These are accounted for within the methodology with a significantly higher weighting factor being applied to such populations.

4. Demographics and Development Control

4.1. Site Selection / Strategic Siting Assessment

For each nuclear power plant site under consideration ONR will determine whether the proposed site (or part of the proposed site) meets the exclusionary demographic criteria stated in Section 3, by considering the demographics out to 30 km around each 100 m x 100 m grid square on the proposed site. ONR will then advise BEIS as to whether the site is potentially suitable for development on demographic grounds, and, where applicable, of any parts of the site that would not be suitable for the siting of a reactor building (due to the semi-urban criteria being exceeded for a particular grid square).

The BEIS Consultation [10] introduced an additional discretionary[2] demographic criterion relating to the practicality of developing appropriate emergency planning arrangements. Where appropriate, ONR will also provide advice with regard to this discretionary demographic criterion including projected population growth in the area and the feasibility of the implementation and maintenance of adequate emergency planning arrangements.

4.2. Site Licensing

ONR undertakes a detailed safety assessment, taking into account the proposed reactor design. At this stage, the prospective licensee must be able to satisfy ONR that:

- the design safety case must show that the nuclear facility will have robust defences against a range of local external hazards, including seismic disturbances and extreme weather events such as flooding;

- the location must be suitable for the establishment of an adequate emergency plan in accordance with the licence conditions and REPPIR; and

- the proposal conforms with Government demographic siting policy.

As part of this process, for proposed new nuclear power plants, the assessment described in Section 4.1 (already undertaken previously as part of the site selection process) will be repeated.

After licensing ONR will undertake a series of further assessments (of the Pre-Construction, Pre-Inactive Commissioning, Pre-Active Commissioning; Pre-Operational, and Station Safety Cases) to ensure that the licensee has demonstrated compliance with its legal duties (e.g. to reduce risks to workers and the public so far as is reasonably practicable). These will include consideration of the licensee's proposed emergency arrangements and (prior to operation) the establishment of an adequate off-site emergency plan.

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[2] Should one or more discretionary criteria not be met, potential mitigation of the adverse impact can be taken into consideration in determining the potential suitability of the site. By contrast, exclusionary criteria are absolute.

4.3. Future Development

Though ONR has no vires with regard to planning decisions by planning authorities, ONR seeks to be consulted in regard to proposed developments within specified consultation zones. These zones are established around those nuclear sites that have the requirement to have a detailed emergency planning zone under the Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR). ONR's advice is primarily determined by its Land Use Planning policy [13] which focuses on the potential impact of new development on the viability, operability and extendibility of the off-site plan and the potential introduction of industrial activities that may pose an external hazard to the nuclear site.

Should a planning authority be minded to grant a development consent order, planning permission or adopt a planning policy within their Local Plan in circumstances where ONR has advised against the proposal, ONR would consider whether the decision presented a serious safety concern. If such a concern was identified, ONR would consider seeking to refer the matter for determination by the relevant Minister, by the appropriate route.

Where potential development around a nuclear power station site is identified by ONR as having the potential to lead to a breach of the demographic siting criteria, ONR will provide advice to the relevant local authorities and government departments regarding the likelihood and safety significance of any such breach.

4.4. Periodic Review of Demographics

ONR will conduct ten-yearly reviews of the demographics around each nuclear power station site, timed to follow the publication of the data from UK national censuses. These will consider the demographics around each reactor building on the site. ONR will then inform the relevant local authorities and government departments of any challenges to the demographic criteria foreseen as likely within the next ten year period.

For sites where such challenges have been identified, ONR may conduct more frequent reviews using population estimates taken from the most recent National Population Database data or derived from consideration of local authority population growth rates and/or population growth projections based on local authority development plans.

5. Technical Basis of Demographic Assessments

Demographic assessments are carried out by analysis of the population distribution out to 30 km around each 100 x 100 m grid square on proposed new nuclear power station sites (or the centre points of reactor buildings on existing sites). Spatial population data (night time residential populations at each National Grid reference point) local to the site are imported into spreadsheets, and the distance and direction of each data point from the relevant reference point are calculated. The 30° sector and radial band within which each data point lies is then determined and the total population within each sector radial band calculated. Weighting factors are then applied to obtain weighted population values for each radial sector band. The weighted population values are then summed for each 30° sector (and all around the site) for radial bands in 1 km increments from 0 – 2 km to 0 – 30 km from the reference point. These Cumulative Weighted Population (CWP) values are then compared with those from a hypothetical site with a notional 0 - 1 km zero population zone and a constant uniform population density from 1 – 30 km.

The 30° sector CWP values for the hypothetical site establish limiting criteria based on the radiological consequences of any given radiological accident. The all around site CWP values for the hypothetical site establishes limiting criteria based on the societal risk associated with such an event.

In the equations below:

- $CWP(\theta, r)$ = Cumulative weighted population values for the sector extending from θ to $\theta+30°$ and from 0 to r km from the centre point;

- $CWP_{360°}(r)$ = Cumulative weighted population values for all around the site extending from 0 to r km from the centre point;

- $\overline{CWP}_{30°}(r)$ = Cumulative weighted population values for the 30° sector with a uniform population density of 5000 persons/km^2, from 0 to r km from the centre point of hypothetical site (with zero population within 1 km);

- $\overline{CWP}_{360°}(r)$ = Cumulative weighted population values with a uniform population density of 1000 persons/km^2 all around the site extending from 0 to r km from the centre point of hypothetical site (with zero population within 1 km);

- $P_{\theta}(r)$ = Population in the sector extending from θ to $\theta+30°$ and from (r-1) to r km from the centre point;

- $P_{360°}(r)$ = Population all around site from (r-1) to r km from the centre point;

- $\bar{P}_{30°}(r)$ = Population in a 30° sector from (r-1) to r km from the centre point of a hypothetical site with a uniform population density of 5000 persons/km^2;

- $\bar{P}_{360°}$ (r) = Population all around site from (r-1) to r km from the centre point of a hypothetical site with a uniform population density of 1000 persons/km^2;

- W_r = Weighting factor for populations within radial distance band between (r-1) and r km from the centre point;

- SPF$_\theta$(r) = Site Population Factor for the sector extending from θ to θ+30° and from 0 to r km from the centre point;

- SPF$_{360°}$(r) = Site Population Factor for all around the site extending from 0 to r km from the centre point.

The following equations are used in demographic assessments:

$$W_r \;=\; 56.542 \times r_m^{-1.5} \tag{1}$$

$$r_m \;=\; \left[\frac{r^2+(r-1)^2}{2}\right]^{0.5} \tag{2}$$

$$CWP_\theta\,(r) \;=\; \sum_{i=1}^{r} W_i \times P_\theta(i) \tag{3}$$

$$CWP_{360°}\,(r) \;=\; \sum_{i=1}^{r} W_i \times P_{360°}(i) \tag{4}$$

$$\overline{CWP}_{30°}(r) \;=\; \sum_{i=1}^{r} W_i \times \bar{P}_{30°}(i) \tag{5}$$

$$\overline{CWP}_{360°}(r) \;=\; \sum_{i=1}^{r} W_i \times \bar{P}_{360°}(i) \tag{6}$$

$$\bar{P}_{30°}(r) \;=\; 5000 \times \frac{\pi(r^2-(r-1)^2)}{12} \tag{7}$$

$$\bar{P}_{360°}(r) \;=\; 1000 \times \pi(r^2 - (r-1)^2) \tag{8}$$

$$SPF_\theta(r) = CWP_\theta\,(r) / \overline{CWP}_{30°}(r) \tag{9}$$

$$SPF_{360°}(r) = CWP_{360°}\,(r) / \overline{CWP}_{360°}(r) \tag{10}$$

Where: r ranges from 1 – 30 km in equations 1 - 4 and from 2 – 30 km in equations 5 – 10; and θ ranges from 0° to 355° in 5° increments.

A given 100 x 100 m grid square (or reactor centre point) meets the semi-urban demographic criteria if -

all SPF$_\theta$(r) and all SPF$_{360°}$(r) are less than 1 [or, equivalently, **SPF$_{MAX}$ < 1**].

6.   Worked Example 1

Tables 1 – 4 below show the radial distribution of population and the calculated SPFs for a hypothetical site which is mainly rural in nature, with a settlement of approximately 5000 persons between 1-2 km from the site centre point. Tables 1 and 2 show the population distribution in the twelve 30° sectors from 0° - 30° (A) to 330° -360° and all around site. From examination of the SPFs in Table 2, it can be seen that no SPF exceeds the limiting value of 1.

However, when the sectors are rotated by 15°, the settlement between 1-2 km from the site centre point lies entirely within a single 30° sector ("E" in Tables 3 and 4, corresponding to 135° - 165° from North). Table 4 shows that this results in the SPF for this sector, in the radial band from 0-2 km from the site centre point, is greater than 1. The site centre point therefore does not meet the semi-urban demographic criteria.

This example illustrates the importance of the use of 5° increments when considering sector-based criteria and the significant impact that population centres close to the site can have on the suitability of a site.

Table 1: Population by radial band (RB) – no rotation, sector A = 0°-30°

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	All
0 - 1	0	0	0	3	2	0	0	0	0	0	0	0	5
1 - 2	1	0	19	35	2686	2705	116	82	0	0	0	0	5643
2 - 3	1	1	20	19	5	9	114	110	0	0	0	0	281
3 - 4	2	0	0	22	22	40	62	22	0	0	0	0	169
4 - 5	2	0	0	30	1433	2012	681	147	75	0	40	101	4521
5 - 6	3	212	22	36	1386	5164	3829	84	47	535	634	163	12115
6 - 7	335	585	16	41	2676	4976	3040	843	461	2692	2587	304	18557
7 - 8	4	487	318	276	599	475	1607	1510	52	5532	5535	12	16408
8 - 9	4	1198	1500	400	166	340	561	410	99	1213	1405	248	7544
9 - 10	5	2739	3717	1162	594	613	411	281	35	266	451	590	10863
10 - 11	111	1483	1773	927	458	342	1391	2039	787	122	93	441	9967
11 - 12	544	1747	460	192	690	781	3342	4390	1731	626	176	217	14896
12 - 13	732	1031	987	292	951	1251	7820	8532	1845	1200	668	655	25965
13 - 14	1413	1813	1103	523	1505	1666	9028	8648	1669	2953	1751	397	32470
14 - 15	2051	1006	509	2051	2844	3780	10757	8384	2621	3225	1241	333	38801

15 - 16	143	1251	235	7176	8193	8682	13389	12974	7259	706	747	374	61130
16 - 17	84	3163	810	1760	1445	7061	15818	16582	7706	585	636	321	55973
17 - 18	9	1320	597	436	477	6284	21033	24175	9169	218	297	210	64226
18 - 19	27	2259	1046	946	1044	803	23104	36985	14432	2089	2219	365	85320
19 - 20	22	3227	3338	491	677	928	26204	38234	12454	1746	1814	1035	90170
20 - 21	11	3632	4483	1657	289	1443	35155	46645	12883	377	545	2579	109701
21 - 22	2529	1242	1272	1388	613	166	23792	33635	12509	2677	331	2303	82455
22 - 23	2895	1675	3548	3709	1624	588	19063	27416	11442	4450	1667	769	78847
23 - 24	3608	2113	3594	3152	967	467	25604	33152	11417	4416	3382	2766	94639
24 - 25	2094	1627	3286	6288	4384	456	14949	20062	7378	2778	875	308	64486
25 - 26	1226	1645	3530	6066	4106	602	8948	14780	7196	4482	3404	313	56298
26 - 27	175	1057	2340	4627	3696	1545	13666	21137	8268	5383	5352	293	67540
27 - 28	170	1664	7054	12000	6442	771	8072	15541	8273	10244	10405	460	81098
28 - 29	255	2541	6660	11034	5040	383	3119	7189	4534	12795	12811	395	66756
29 - 30	2123	2850	4824	6597	2422	786	1624	1974	2968	13961	12829	1244	54201

Table 2: Calculated Site Population Factors – no rotation, sector A = 0°-30°

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	All
0 - 1													
0 - 2	0.00	0.00	0.00	0.01	0.69	0.69	0.03	0.02	0.00	0.00	0.00	0.00	0.60
0 - 3	0.00	0.00	0.00	0.01	0.38	0.38	0.02	0.02	0.00	0.00	0.00	0.00	0.34
0 - 4	0.00	0.00	0.00	0.01	0.27	0.28	0.02	0.01	0.00	0.00	0.00	0.00	0.25
0 - 5	0.00	0.00	0.00	0.01	0.24	0.26	0.03	0.01	0.00	0.00	0.00	0.00	0.23
0 - 6	0.00	0.00	0.00	0.00	0.22	0.27	0.06	0.01	0.00	0.01	0.01	0.00	0.25
0 - 7	0.00	0.01	0.00	0.00	0.21	0.27	0.08	0.02	0.00	0.02	0.03	0.00	0.27
0 - 8	0.00	0.01	0.00	0.01	0.19	0.25	0.08	0.02	0.00	0.05	0.05	0.00	0.28
0 - 9	0.00	0.01	0.01	0.01	0.18	0.23	0.07	0.02	0.00	0.05	0.05	0.01	0.27
0 - 10	0.00	0.02	0.02	0.01	0.17	0.21	0.07	0.02	0.00	0.05	0.05	0.01	0.26
0 - 11	0.00	0.02	0.02	0.01	0.16	0.20	0.07	0.03	0.01	0.05	0.05	0.01	0.25
0 - 12	0.00	0.02	0.02	0.01	0.15	0.19	0.07	0.03	0.01	0.04	0.04	0.01	0.25
0 - 13	0.00	0.02	0.02	0.01	0.14	0.18	0.08	0.05	0.01	0.04	0.04	0.01	0.26
0 - 14	0.01	0.03	0.02	0.01	0.14	0.17	0.09	0.06	0.01	0.05	0.04	0.01	0.26
0 - 15	0.01	0.03	0.02	0.01	0.13	0.17	0.10	0.06	0.02	0.05	0.04	0.01	0.27

0 - 16	0.01	0.03	0.02	0.02	0.14	0.17	0.11	0.07	0.02	0.05	0.04	0.01	0.29
0 - 17	0.01	0.03	0.02	0.02	0.13	0.17	0.12	0.09	0.03	0.04	0.04	0.01	0.30
0 - 18	0.01	0.03	0.02	0.02	0.13	0.17	0.13	0.10	0.04	0.04	0.04	0.01	0.31
0 - 19	0.01	0.03	0.02	0.02	0.12	0.16	0.14	0.13	0.04	0.04	0.04	0.01	0.32
0 - 20	0.01	0.03	0.02	0.02	0.12	0.16	0.16	0.15	0.05	0.04	0.04	0.01	0.34
0 - 21	0.01	0.03	0.03	0.02	0.12	0.16	0.17	0.17	0.06	0.04	0.04	0.01	0.35
0 - 22	0.01	0.03	0.02	0.02	0.11	0.15	0.18	0.18	0.06	0.04	0.04	0.01	0.36
0 - 23	0.01	0.03	0.03	0.02	0.11	0.15	0.18	0.19	0.07	0.04	0.04	0.01	0.36
0 - 24	0.01	0.03	0.03	0.02	0.11	0.14	0.19	0.20	0.07	0.04	0.04	0.01	0.37
0 - 25	0.01	0.03	0.03	0.02	0.11	0.14	0.19	0.20	0.07	0.04	0.04	0.01	0.37
0 - 26	0.01	0.03	0.03	0.03	0.11	0.14	0.19	0.20	0.07	0.04	0.04	0.01	0.37
0 - 27	0.01	0.03	0.03	0.03	0.11	0.13	0.19	0.21	0.07	0.04	0.04	0.01	0.37
0 - 28	0.01	0.03	0.03	0.03	0.10	0.13	0.19	0.21	0.07	0.05	0.04	0.01	0.38
0 - 29	0.01	0.03	0.03	0.03	0.10	0.13	0.18	0.20	0.07	0.05	0.04	0.01	0.38
0 - 30	0.01	0.03	0.03	0.03	0.10	0.13	0.18	0.20	0.07	0.05	0.05	0.01	0.37

Table 3: Population by radial band – 15° rotation, sector A = 15°-45°

RB (km)	A+15°	B+15°	C+15°	D+15°	E+15°	F+15°	G+15°	H+15°	I+15°	J+15°	K+15°	L+15°	All
0 - 1	0	0	0	5	0	0	0	0	0	0	0	0	5
1 - 2	0	0	39	31	5341	68	164	0	0	0	0	0	5642
2 - 3	0	2	39	0	10	8	221	0	0	0	0	0	280
3 - 4	0	0	0	43	0	80	44	0	0	0	0	0	168
4 - 5	0	0	0	60	2807	1218	144	150	0	0	80	121	4579
5 - 6	424	0	44	27	2745	7583	75	94	0	1070	198	127	12388
6 - 7	1169	0	33	50	5302	4651	1428	257	665	4719	455	152	18881
7 - 8	347	628	8	545	654	297	2917	103	0	11064	7	18	16586
8 - 9	44	2353	647	154	178	502	621	198	0	2426	383	112	7618
9 - 10	76	5402	2032	292	896	330	493	69	0	531	372	808	11301
10 - 11	979	1988	1558	297	619	65	2716	1362	213	31	156	725	10707
11 - 12	2849	646	275	109	1271	291	6392	2387	1076	177	174	259	15907
12 - 13	458	1605	368	216	1686	816	14825	2238	1452	948	389	921	25922
13 - 14	1503	2123	83	963	2047	1285	16772	524	2814	3093	410	384	32000
14 - 15	1068	944	74	4029	1658	5901	15613	1154	4087	2363	119	547	37558

15 - 16	2286	215	255	14097	2289	15075	11703	14246	272	1141	352	396	62328
16 - 17	5724	603	1017	2502	389	13733	17904	15260	153	1017	255	387	58944
17 - 18	1878	762	432	441	514	12054	30011	18339	0	436	159	262	65288
18 - 19	2769	1749	343	1550	539	1067	45141	28829	36	4143	296	434	86895
19 - 20	437	6016	660	322	1033	824	51584	24883	25	3466	162	1908	91320
20 - 21	1135	6130	2837	478	101	2786	67525	25764	2	752	339	4820	112668
21 - 22	1528	955	1588	1187	39	293	47290	19980	5038	317	344	4262	82821
22 - 23	1191	2160	4937	2481	767	409	37718	17115	5768	3132	202	1336	77215
23 - 24	1797	2430	4759	1545	390	544	50664	15641	7193	1638	5126	407	92133
24 - 25	1038	2217	4354	8222	547	365	29533	10592	4164	1392	358	257	63039
25 - 26	1050	2240	4821	7310	903	300	17596	11963	2428	6537	271	356	55774
26 - 27	1117	998	3682	5573	1818	1271	26061	16213	324	10442	263	323	68084
27 - 28	582	2746	11363	12637	247	1296	14849	16233	313	20176	634	287	81363
28 - 29	4068	1014	12307	9761	318	447	5791	8587	481	25110	512	278	68673
29 - 30	4954	747	8902	4292	552	1020	2228	1720	4216	23706	1952	536	54823

Table 4: Calculated Site Population Factors – 15° rotation, sector A = 15°-45°

RB (km)	A+15°	B+15°	C+15°	D+15°	E+15°	F+15°	G+15°	H+15°	I+15°	J+15°	K+15°	L+15°	All
0 - 1													
0 - 2	0.00	0.00	0.01	0.01	1.36	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.60
0 - 3	0.00	0.00	0.01	0.01	0.75	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.34
0 - 4	0.00	0.00	0.01	0.01	0.54	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.25
0 - 5	0.00	0.00	0.00	0.01	0.48	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.23
0 - 6	0.00	0.00	0.00	0.01	0.44	0.10	0.02	0.00	0.00	0.01	0.00	0.00	0.25
0 - 7	0.01	0.00	0.00	0.00	0.42	0.12	0.03	0.00	0.00	0.04	0.01	0.00	0.27
0 - 8	0.01	0.00	0.00	0.01	0.38	0.11	0.04	0.00	0.00	0.10	0.01	0.00	0.28
0 - 9	0.01	0.01	0.01	0.01	0.35	0.11	0.04	0.01	0.00	0.10	0.01	0.00	0.27
0 - 10	0.01	0.03	0.01	0.01	0.33	0.10	0.04	0.00	0.00	0.09	0.01	0.01	0.26
0 - 11	0.01	0.03	0.01	0.01	0.30	0.09	0.04	0.01	0.00	0.09	0.01	0.01	0.25
0 - 12	0.02	0.03	0.01	0.01	0.29	0.09	0.05	0.01	0.01	0.08	0.01	0.01	0.25
0 - 13	0.02	0.03	0.01	0.01	0.28	0.08	0.08	0.02	0.01	0.08	0.01	0.01	0.26
0 - 14	0.02	0.03	0.01	0.01	0.26	0.08	0.10	0.02	0.01	0.08	0.01	0.01	0.26
0 - 15	0.02	0.03	0.01	0.01	0.25	0.08	0.11	0.02	0.02	0.08	0.01	0.01	0.27

0 - 16	0.02	0.03	0.01	0.03	0.25	0.10	0.12	0.03	0.02	0.08	0.01	0.01	0.29
0 - 17	0.03	0.03	0.01	0.03	0.24	0.11	0.13	0.04	0.02	0.07	0.01	0.01	0.30
0 - 18	0.03	0.03	0.01	0.03	0.23	0.11	0.15	0.06	0.01	0.07	0.01	0.01	0.31
0 - 19	0.03	0.03	0.01	0.03	0.22	0.11	0.18	0.08	0.01	0.07	0.01	0.01	0.32
0 - 20	0.03	0.03	0.01	0.03	0.21	0.11	0.21	0.09	0.01	0.07	0.01	0.01	0.34
0 - 21	0.03	0.04	0.01	0.03	0.21	0.10	0.24	0.10	0.01	0.07	0.01	0.01	0.35
0 - 22	0.03	0.04	0.01	0.03	0.20	0.10	0.26	0.11	0.02	0.07	0.01	0.01	0.36
0 - 23	0.03	0.04	0.02	0.03	0.20	0.10	0.27	0.11	0.02	0.07	0.01	0.01	0.36
0 - 24	0.03	0.04	0.02	0.03	0.19	0.10	0.28	0.12	0.02	0.07	0.01	0.01	0.37
0 - 25	0.03	0.04	0.02	0.03	0.19	0.09	0.29	0.12	0.02	0.07	0.01	0.01	0.37
0 - 26	0.03	0.04	0.02	0.03	0.18	0.09	0.29	0.12	0.02	0.07	0.01	0.01	0.37
0 - 27	0.03	0.03	0.02	0.03	0.18	0.09	0.29	0.12	0.02	0.07	0.01	0.01	0.37
0 - 28	0.03	0.03	0.02	0.04	0.17	0.09	0.29	0.13	0.02	0.07	0.01	0.01	0.38
0 - 29	0.03	0.03	0.03	0.04	0.17	0.09	0.28	0.13	0.02	0.08	0.01	0.01	0.38
0 - 30	0.03	0.03	0.03	0.04	0.17	0.08	0.28	0.12	0.02	0.08	0.01	0.01	0.37

7. Worked Example 2

Three potential sites (Sites 1, 2 and 3) for a new nuclear power station are under consideration during a strategic siting assessment. Each site is 20 km from the centre of City B: Site 1 is to the southwest, Site 2 is (approximately) to the northwest; and Site 3 is to the northeast. City B extends radially for 4 km from the city centre and an assumed uniform population density of 20000 persons per square kilometre, with a total population being just over 1 million persons. Identical cities lie 25 km to the north (City A) and 25 km to the east (City C) of City B (where distances are measured from each city centre). Outside of these three metropolitan areas, population density is roughly 400 persons per square kilometre. The relationship between city and site locations is shown in Figure 2 below.
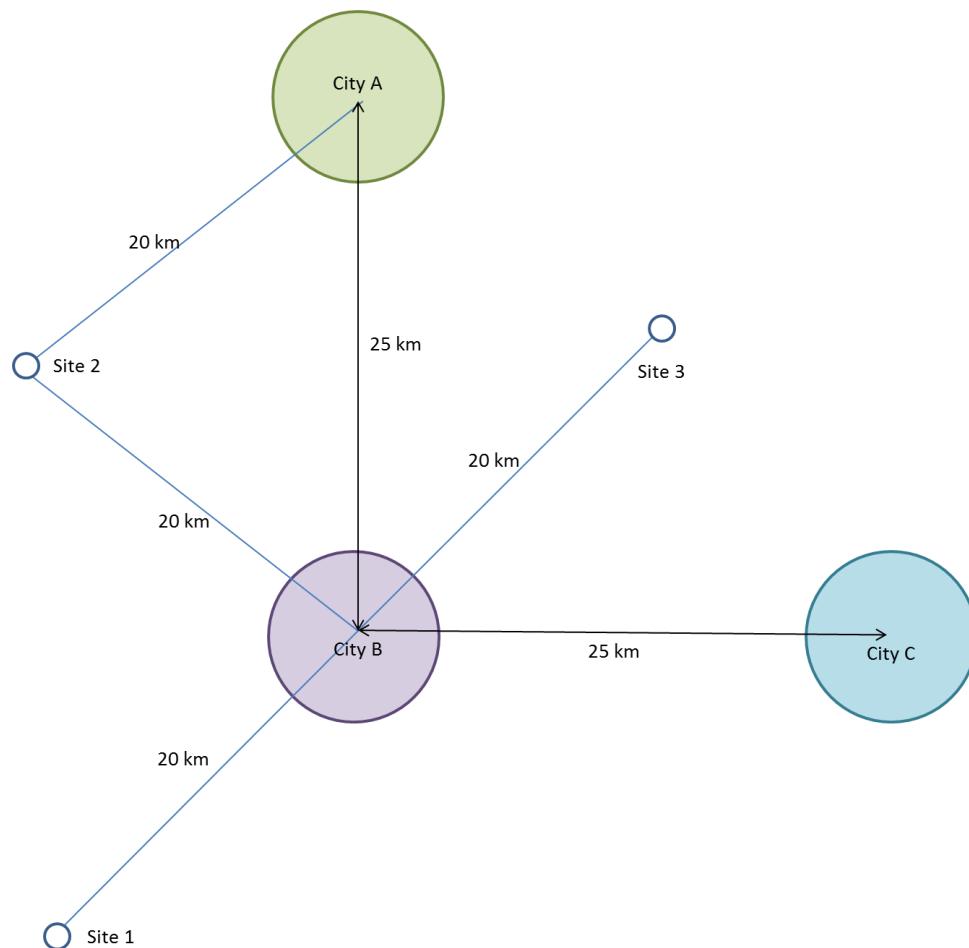
Figure 2: Relationship between city and site locations in Worked Example 2.

Tables 5 and 6 show the radial distribution of population and the calculated SPFs for Site 1. The maximum SPF is 0.66 for sector B in the radial band from 0-24 km. The application of 5° rotations does not increase the maximum SPF, and these are not presented below. The site therefore meets the semi-urban criteria and would be considered potentially suitable for the deployment of a nuclear power station based on demographics.

Tables 7 and 8 show the radial distribution of population and the calculated SPFs for Site 2. The maximum SPF is 0.89 for all around site in the radial band from 0-24 km. The application of 5° rotations does not increase the maximum SPF, and again these are not presented below. The site therefore meets the semi-urban criteria and would be considered potentially suitable for the deployment of a nuclear power station based on demographics. However, as the maximum all around site SPF is close to the limit, constraints on future development around the site may be required to ensure that the semi-urban criteria are met at the time of the licensing of the site and to maintain the demographic characteristics of the area throughout the operational lifetime of the power station. Such constraints may be applied in all sectors out to at least 24 km from the site and, although the site meets the semi-urban criteria, it would be likely to be excluded from further consideration if such constraints were considered to be impractical.

Tables 9 and 10 show the radial distribution of population and the calculated SPFs for Site 3. Although all sector SPFs (including those under rotation) are less than 1, the cumulative effect of having three major population centres within 20 km of the site results in all around site SPFs of greater than 1 for multiple sector bands from 0 – 20 km outwards. The site therefore fails to meet the semi-urban criteria and would be excluded from further consideration based on demographics.

Table 5: Population by radial band (RB) around Site 1, 20 km SW of City B – no rotation, sector A = 0°-30°

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	All
0 - 1	0	0	0	0	0	0	0	0	0	0	0	0	0
1 - 2	400	400	400	400	400	400	400	400	400	400	400	400	4800
2 - 3	800	0	800	400	800	400	800	400	800	400	800	400	6800
3 - 4	800	1200	800	400	800	800	400	800	400	800	800	400	8400
4 - 5	1200	400	1200	800	800	1600	800	1200	800	1600	800	800	12000
5 - 6	1200	1200	1200	1200	1200	1200	800	1200	800	1200	1200	1200	13600
6 - 7	1600	1600	1600	1200	800	1600	1200	1200	1200	1600	800	1200	15600
7 - 8	1600	1200	1600	1200	2000	1600	1600	1600	1600	1600	2000	1200	18800
8 - 9	1600	2800	1600	1600	1600	2000	1600	1200	1600	2000	1600	1600	20800
9 - 10	2000	1600	2000	2000	2400	2000	1600	2800	1600	2000	2400	2000	24400
10 - 11	2800	2000	2800	2000	2400	2000	2400	1600	2400	2000	2400	2000	26800
11 - 12	2400	2800	2400	2000	2000	2400	2000	2800	2000	2400	2000	2000	27200
12 - 13	2800	2000	2800	2400	3200	3200	2800	2800	2800	3200	3200	2400	33600
13 - 14	2800	3200	2800	2800	2400	2800	2400	2800	2400	2800	2400	2800	32400
14 - 15	3200	6600	3200	3200	3200	3200	2800	3200	2800	3200	3200	3200	41000

15 - 16	3600	8800	3600	2800	3200	3200	3600	2800	3600	3200	3200	2800	44400
16 - 17	3600	67200	3600	3200	3200	4000	3200	3600	3200	4000	3200	3200	105200
17 - 18	3600	120600	3600	3600	4400	4000	3200	4000	3200	4000	4400	3600	162200
18 - 19	4400	146200	4400	3600	3200	4000	3600	3600	3600	4000	3200	3600	187400
19 - 20	4000	161800	4000	4000	4400	4000	4000	4400	4000	4000	4400	4000	207000
20 - 21	5600	167000	4400	4400	3600	4800	4000	4000	4000	4800	3600	4400	214600
21 - 22	4400	158200	4400	4000	4800	4400	4800	4400	4800	4400	4800	4000	207400
22 - 23	4800	139000	4800	5200	4800	5200	4400	4400	4400	5200	4800	5200	192200
23 - 24	5600	89400	5600	4400	4400	4800	5200	5200	5200	4800	4400	4400	143400
24 - 25	5200	6800	5200	4800	6000	4800	4800	4800	4800	4800	6000	4800	62800
25 - 26	5200	5200	5200	4800	4800	6000	4800	6000	4800	6000	4800	4800	62400
26 - 27	5600	4800	5600	5600	6400	4400	4400	5200	4400	4400	6400	5600	62800
27 - 28	6000	6800	6000	6400	5200	2400	2800	5600	2800	2400	5200	6400	58000
28 - 29	6400	5200	6400	5600	5200	1600	1600	6800	1600	1600	5200	5600	52800
29 - 30	6000	6800	6000	5600	7200	800	800	5200	800	800	7200	5600	52800

Table 6: Calculated Site Population Factors for Site 1, 20 km SW of City B – no rotation, sector A = 0°-30°

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	**All**
0 - 1													
0 - 2	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.51
0 - 3	0.11	0.06	0.11	0.08	0.11	0.08	0.11	0.08	0.11	0.08	0.11	0.08	0.48
0 - 4	0.10	0.08	0.10	0.07	0.10	0.08	0.09	0.08	0.09	0.08	0.10	0.07	0.45
0 - 5	0.10	0.07	0.10	0.07	0.10	0.09	0.09	0.09	0.09	0.09	0.10	0.07	0.44
0 - 6	0.10	0.07	0.10	0.07	0.10	0.09	0.08	0.09	0.08	0.09	0.10	0.07	0.44
0 - 7	0.10	0.07	0.10	0.07	0.09	0.09	0.08	0.09	0.08	0.09	0.09	0.07	0.43
0 - 8	0.10	0.07	0.10	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.43
0 - 9	0.10	0.08	0.10	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 10	0.09	0.08	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 11	0.10	0.08	0.10	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 12	0.09	0.08	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 13	0.09	0.08	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 14	0.09	0.08	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 15	0.09	0.08	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42

0 - 16	0.09	0.09	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.42
0 - 17	0.09	0.15	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.44
0 - 18	0.09	0.24	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.48
0 - 19	0.09	0.34	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.52
0 - 20	0.09	0.43	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.56
0 - 21	0.09	0.52	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.60
0 - 22	0.09	0.58	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.62
0 - 23	0.09	0.63	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.64
0 - 24	0.09	0.66	0.09	0.07	0.08	0.09	0.08	0.08	0.08	0.09	0.08	0.07	0.65
0 - 25	0.09	0.64	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.65
0 - 26	0.09	0.63	0.09	0.07	0.08	0.09	0.08	0.08	0.08	0.09	0.08	0.07	0.64
0 - 27	0.09	0.61	0.09	0.07	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.07	0.63
0 - 28	0.09	0.60	0.09	0.07	0.08	0.09	0.08	0.08	0.08	0.09	0.08	0.07	0.63
0 - 29	0.09	0.59	0.09	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.62
0 - 30	0.09	0.58	0.09	0.07	0.08	0.08	0.07	0.08	0.07	0.08	0.08	0.07	0.61

Table 7: Population by radial band around Site 2, 20 km from centres of Cities A and B, no rotation

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	All
0 - 1	0	0	0	0	0	0	0	0	0	0	0	0	0
1 - 2	400	400	400	400	400	400	400	400	400	400	400	400	4800
2 - 3	400	800	400	400	800	400	800	800	400	400	800	800	7200
3 - 4	800	400	1200	1200	400	800	800	400	800	800	400	800	8800
4 - 5	800	800	800	800	800	800	800	1200	800	800	1200	800	10400
5 - 6	800	1600	1200	1200	1600	800	1600	800	1600	1600	800	1600	15200
6 - 7	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	14400
7 - 8	2000	2000	1600	1600	2000	2000	1600	2000	1600	1600	2000	1600	21600
8 - 9	1600	1600	2000	2000	1600	1600	1600	1600	1600	1600	1600	1600	20000
9 - 10	2000	1600	2000	2000	1600	2000	2000	2000	2000	2000	2000	2000	23200
10 - 11	2000	2400	2000	2000	2400	2000	2400	2400	2400	2400	2400	2400	27200
11 - 12	2400	2000	2800	2800	2000	2400	2800	2000	2400	2400	2000	2800	28800
12 - 13	2400	3600	2400	2400	3600	2400	2400	3200	2400	2400	3200	2400	32800
13 - 14	3200	2000	2800	2800	2000	3200	2800	2000	3200	3200	2000	2800	32000
14 - 15	2800	3200	2800	2800	5200	2800	3200	3600	2800	2800	3600	3200	38800

15 - 16	3600	2800	4000	4000	6000	3600	3200	3200	3200	3200	3200	3200	43200
16 - 17	3200	63000	3200	3200	71800	3200	3200	3600	3600	3600	3600	3200	168400
17 - 18	3600	114200	7800	9800	118200	3600	3600	3600	3600	3600	3600	3600	278800
18 - 19	3600	129400	18000	20000	133600	3600	4400	3600	4000	4000	3600	4400	332200
19 - 20	4000	142200	22400	24200	146000	4000	4400	4400	4000	4000	4400	4400	368400
20 - 21	4400	145800	22800	24400	145400	4400	4000	4400	4000	4000	4400	4000	372000
21 - 22	4800	146400	16200	17600	144400	4800	4400	4400	4400	4400	4400	4400	360600
22 - 23	4400	138800	6000	6400	136400	4400	4800	4800	4800	4800	4800	4800	325200
23 - 24	5200	88400	4800	4800	82600	5200	4800	5200	5200	5200	5200	4800	221400
24 - 25	4800	8200	5200	5200	6800	4800	5600	4800	4800	4800	4800	5600	65400
25 - 26	5600	4400	5200	5200	4400	5600	5200	4800	3200	3200	4800	5200	56800
26 - 27	5200	5600	6000	6000	5600	5200	5200	6000	2000	2000	6000	5200	60000
27 - 28	5200	6400	5600	5600	6400	5200	6400	5200	1200	1200	5200	6400	60000
28 - 29	4400	4800	6400	6400	4800	6400	5600	6800	6800	6800	6800	3600	69600
29 - 30	2400	7600	6000	6000	7600	6000	6400	5200	5200	5200	5200	2400	65200

Table 8: Calculated Site Population Factors for Site 2, 20 km from centres of Cities A and B, no rotation

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	**All**
0 - 1													
0 - 2	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.51
0 - 3	0.08	0.11	0.08	0.08	0.11	0.08	0.11	0.11	0.08	0.08	0.11	0.11	0.49
0 - 4	0.08	0.09	0.10	0.10	0.09	0.08	0.10	0.09	0.08	0.08	0.09	0.10	0.46
0 - 5	0.08	0.09	0.09	0.09	0.09	0.08	0.10	0.09	0.08	0.08	0.09	0.10	0.44
0 - 6	0.08	0.09	0.09	0.09	0.09	0.08	0.10	0.09	0.09	0.09	0.09	0.10	0.44
0 - 7	0.08	0.09	0.09	0.09	0.09	0.08	0.10	0.09	0.08	0.08	0.09	0.10	0.43
0 - 8	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.43
0 - 9	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.43
0 - 10	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.43
0 - 11	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.43
0 - 12	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.42
0 - 13	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.42
0 - 14	0.08	0.09	0.09	0.09	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.42
0 - 15	0.08	0.09	0.08	0.08	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.42

0 - 16	0.08	0.08	0.09	0.09	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.42
0 - 17	0.08	0.14	0.08	0.08	0.15	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.47
0 - 18	0.08	0.23	0.09	0.09	0.24	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.55
0 - 19	0.08	0.31	0.10	0.10	0.33	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.63
0 - 20	0.08	0.40	0.11	0.11	0.42	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.71
0 - 21	0.08	0.47	0.12	0.12	0.49	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.78
0 - 22	0.08	0.53	0.12	0.13	0.55	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.83
0 - 23	0.08	0.58	0.12	0.13	0.60	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.87
0 - 24	0.08	0.61	0.12	0.13	0.62	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.89
0 - 25	0.08	0.59	0.12	0.13	0.61	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.88
0 - 26	0.08	0.58	0.12	0.13	0.59	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.87
0 - 27	0.08	0.57	0.12	0.12	0.58	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.85
0 - 28	0.08	0.56	0.12	0.12	0.57	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.84
0 - 29	0.08	0.55	0.12	0.12	0.56	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.83
0 - 30	0.08	0.54	0.12	0.12	0.55	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.82

Table 9: Population by radial band around Site 3, 20 km NE of City B, no rotation

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	All
0 - 1	0	0	0	0	0	0	0	0	0	0	0	0	0
1 - 2	400	400	400	400	400	400	400	400	400	400	400	400	4800
2 - 3	800	400	800	400	800	400	800	0	800	400	800	400	6800
3 - 4	400	800	400	800	800	400	800	1200	800	400	800	800	8400
4 - 5	800	1200	800	1600	800	800	1200	400	1200	800	800	1600	12000
5 - 6	800	1200	800	1200	1200	1200	1200	1200	1200	1200	1200	1200	13600
6 - 7	1200	1200	1200	1600	800	1200	1600	1600	1600	1200	800	1600	15600
7 - 8	1600	1600	1600	1600	2000	1200	1600	1200	1600	1200	2000	1600	18800
8 - 9	1600	1200	1600	2000	1600	1600	1600	2800	1600	1600	1600	2000	20800
9 - 10	1600	2800	1600	2000	2400	2000	2000	1600	2000	2000	2400	2000	24400
10 - 11	2400	1600	2400	2000	2400	2000	2800	2000	2800	2000	2400	2000	26800
11 - 12	2000	2800	2000	2400	2000	2000	2400	2800	2400	2000	2000	2400	27200
12 - 13	2800	2800	2800	3200	3200	2400	2800	2000	2800	2400	3200	3200	33600
13 - 14	2400	2800	2400	2800	7400	2800	2800	3200	2800	2800	7400	2800	42400
14 - 15	2800	3200	2800	3200	78600	6400	3200	2800	3200	6400	78600	3200	194400

15 - 16	3600	2800	3600	3200	105600	21800	3600	5200	3600	21800	105600	3200	283600
16 - 17	3200	3600	3200	4000	120200	31000	3600	74600	3600	31000	120200	4000	402200
17 - 18	3200	4000	3200	4000	130600	35200	3600	122200	3600	35200	130600	4000	479400
18 - 19	3600	3600	3600	4000	133200	34000	4400	146600	4400	34000	133200	4000	508600
19 - 20	4000	4400	4000	4000	132200	26800	4000	161200	4000	26800	132200	4000	507600
20 - 21	4000	4000	4000	4800	122000	12400	4400	166000	5200	12400	122000	4800	466000
21 - 22	4800	4400	4800	4400	64600	4000	4400	160400	4400	4000	64600	4400	329200
22 - 23	4400	4400	4400	5200	4800	5200	4800	137800	4800	5200	4800	5200	191000
23 - 24	5200	5200	5200	4800	4400	4400	5600	80200	5600	4400	4400	4800	134200
24 - 25	4800	4800	4800	4800	6000	4800	5200	11200	5200	4800	6000	4800	67200
25 - 26	4800	6000	4800	6000	4800	4800	5200	9000	5200	4800	4800	6000	66200
26 - 27	4400	5200	4400	4400	6400	5600	5600	4800	5600	5600	6400	4400	62800
27 - 28	5600	5600	5600	5600	5200	6400	6000	6800	6000	6400	5200	5600	70000
28 - 29	5800	6800	5800	5800	5200	5600	6400	5200	6400	5600	5200	5800	69600
29 - 30	6200	5200	6200	6200	7200	5600	6000	6800	6000	5600	7200	6200	74400

Table 10: Calculated Site Population Factors for Site 3, 20 km northwest of City B, no rotation

RB (km)	A	B	C	D	E	F	G	H	I	J	K	L	**All**
0 - 1													
0 - 2	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.51
0 - 3	0.11	0.08	0.11	0.08	0.11	0.08	0.11	0.06	0.11	0.08	0.11	0.08	0.48
0 - 4	0.09	0.08	0.09	0.08	0.10	0.07	0.10	0.08	0.10	0.07	0.10	0.08	0.45
0 - 5	0.09	0.09	0.09	0.09	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.09	0.44
0 - 6	0.08	0.09	0.08	0.09	0.10	0.07	0.10	0.07	0.10	0.07	0.10	0.09	0.44
0 - 7	0.08	0.09	0.08	0.09	0.09	0.07	0.10	0.07	0.10	0.07	0.09	0.09	0.43
0 - 8	0.08	0.08	0.08	0.09	0.09	0.07	0.10	0.07	0.10	0.07	0.09	0.09	0.43
0 - 9	0.08	0.08	0.08	0.09	0.09	0.07	0.10	0.08	0.10	0.07	0.09	0.09	0.42
0 - 10	0.08	0.08	0.08	0.09	0.09	0.07	0.09	0.08	0.09	0.07	0.09	0.09	0.42
0 - 11	0.08	0.08	0.08	0.09	0.09	0.07	0.10	0.08	0.10	0.07	0.09	0.09	0.42
0 - 12	0.08	0.08	0.08	0.09	0.09	0.07	0.09	0.08	0.09	0.07	0.09	0.09	0.42
0 - 13	0.08	0.08	0.08	0.09	0.09	0.07	0.09	0.08	0.09	0.07	0.09	0.09	0.42
0 - 14	0.08	0.08	0.08	0.09	0.09	0.07	0.09	0.08	0.09	0.07	0.09	0.09	0.42
0 - 15	0.08	0.08	0.08	0.09	0.19	0.08	0.09	0.08	0.09	0.08	0.19	0.09	0.50

0 - 16	0.08	0.08	0.08	0.09	0.29	0.10	0.09	0.08	0.09	0.10	0.29	0.09	0.61
0 - 17	0.08	0.08	0.08	0.09	0.39	0.12	0.09	0.15	0.09	0.12	0.39	0.09	0.74
0 - 18	0.08	0.08	0.08	0.09	0.48	0.15	0.09	0.24	0.09	0.15	0.48	0.09	0.87
0 - 19	0.08	0.08	0.08	0.09	0.56	0.17	0.09	0.34	0.09	0.17	0.56	0.09	1.00
0 - 20	0.08	0.08	0.08	0.09	0.63	0.18	0.09	0.43	0.09	0.18	0.63	0.09	1.10
0 - 21	0.08	0.08	0.08	0.09	0.68	0.18	0.09	0.51	0.09	0.18	0.68	0.09	1.18
0 - 22	0.08	0.08	0.08	0.09	0.70	0.18	0.09	0.58	0.09	0.18	0.70	0.09	1.22
0 - 23	0.08	0.08	0.08	0.09	0.68	0.17	0.09	0.63	0.09	0.17	0.68	0.09	1.22
0 - 24	0.08	0.08	0.08	0.09	0.66	0.17	0.09	0.65	0.09	0.17	0.66	0.09	1.21
0 - 25	0.08	0.08	0.08	0.09	0.65	0.17	0.09	0.64	0.09	0.17	0.65	0.09	1.19
0 - 26	0.08	0.08	0.08	0.09	0.63	0.17	0.09	0.63	0.09	0.17	0.63	0.09	1.17
0 - 27	0.08	0.08	0.08	0.09	0.62	0.16	0.09	0.61	0.09	0.16	0.62	0.09	1.16
0 - 28	0.08	0.08	0.08	0.09	0.61	0.16	0.09	0.60	0.09	0.16	0.61	0.09	1.14
0 - 29	0.08	0.08	0.08	0.09	0.60	0.16	0.09	0.59	0.09	0.16	0.60	0.09	1.12
0 - 30	0.08	0.08	0.08	0.09	0.59	0.16	0.09	0.58	0.09	0.16	0.59	0.09	1.11

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