RANDOM SAMPLE SITE LOCATION

1 SCOPE

This method describes the procedure for the random selection of samples sites in a lot of material production or road construction. The method provides for stratified and unstratified random sampling on the basis of area, volume or time.

2 DEFINTIONS

(a) The principles used to define the limits of any **Lot** shall be;

i. The maximum size of a Lot is limited to the quantity of work that is the subject of a single conformance decision;
ii. The whole of the works included in the Lot shall be continuous;
iii. The Lot has been produced by the same works process;
iv. The Lot has been bought to completion at the same time; and
v. The Lot shall appear to be of a constant quality without obvious changes in attribute values, whether or not these attributes form part of the acceptance criteria

(b) A **random sample site** is the random position within a lot at which a single test sample is taken or at which a single insitu test is performed.

(c) **Unstratified random sampling** is the selection of samples from a lot so that each part of the population of the lot has an equal and independent chance of being chosen as a sample.

(d) **Stratified random sampling** is the selection of random samples from sub-lots or strata of approximately equal size into which the lot has been divided**.**

3 APPARATUS

(a) **Random number tables** or **random number generator.**

(b) **Measuring device** such as ruler, tape, distance measuring wheel and/or timing device.

4 PROCEDURE

Random sampling does not mean haphazard sampling and requires a detailed predetermined sampling plan, which eliminates bias. Such a sampling plan may be stratified or unstratified according to circumstances. Unstratified random sampling provides a statistically valid method however it has the disadvantage that sample locations may be clustered close together physically and this may cause producer or consumer dissatisfaction. Stratified random sampling overcomes this problem by dividing the lot into sub-lots, which ensures sample sites are spread throughout the lot.

The required number of test samples or sample sites will vary according to the reason for sampling or testing. In sampling and testing associated with the execution of contracts the number of test samples or sample sites will normally be specified in the contract documents. In other cases the Project Manager will normally stipulate the number required. The number selected should be related to the variability of the material in question and the confidence required in the test results.

4.1 UNSTRATIFIED RANDOM SAMPLING

4.1.1 Locating Sample Sites in a Rectangular Area

The procedure described in this part of the method uses rectangular co-ordinates to locate sample sites in approximately rectangular areas.

NOTE: Although the sampling plan is based on rectangular co-ordinates, the distortion of these co-ordinates necessary for the system to be used on curved sections of road is acceptable.

(a) Determine the width and length of the lot.

(b) Determine the number of test samples required in the lot.

(c) Devise an imaginary grid of the area of the lot such that any point in the lot can be represented by two numbers, one that refers to the *x* co-ordinate (width) and the other the *y* co-ordinate (length) of the grid.

NOTE: Only positive co-ordinates should be used and the co-ordinates axes should be located so as to represent selected boundaries of the lot or sub-lot. A representation of the grid and lot or sub-lot may be drawn on paper to assist planning.

(d) Select the units of the x and y co-ordinates such that they represent suitable increments of the actual width and length of the lot.

NOTE: The units selected should represent practical increments of length, width or area appropriate to the type of sampling or testing involved. The increments should be small enough to give all parts of the lot or sub-lot an equal chance of selection but large enough to ensure independence. In general units - representing increments of between 0.5 m and 1 m or 0.25 m^2 and 1.0 m^2 should be appropriate.

(e) Select pairs of random numbers in accordance with Procedure 4.3, to represent the *x* and *y* co-ordinates of the required number of sample sites in the grid.

NOTE: When selecting pairs of random numbers it is usual to select all the y co-ordinates required first then to select the x co-ordinates.

(f) Locate the sample sites in the lot at the co-ordinates represented by the pairs of random numbers by physical measurement to within a 0.5 metre radius.
NOTE: In general the finite area required for sampling or testing should be sited to encompass the sample site so located. In the case of co-ordinates falling on the boundary of a lot the site should be offset to within the lot by the distance required to accommodate the sampling or testing involved.

4.1.2 Locating Sample Sites in an Area of any Shape

(a) Determine the size and boundaries of the lot.

(b) Determine the number of test samples required in the lot.

(c) Consider the lot to be divided into approximately equal size parts that represent suitable increments of the lot area using an imaginary grid or other means.

NOTE: Refer to note 4.1.1(d)

(d) Number the parts consecutively. Figure 2 provides some examples of how this is conducted.

(e) Select random numbers in accordance with Procedure 4.3, within the range used to number the parts, which represent the required number of sample sites.

(f) Locate the parts represented by the random numbers selected by physical measurement. The sample sites shall be within the parts so located.

NOTE: Refer to note 4.1.1(f)

4.1.3 Locating Sample Sites in a Stockpile

This procedure is applicable to small stockpiles, of less than approximately 500m^3, which are approximately rectangular in plan. Sample site selection of other shapes can be selected in a similar manner.

(a) Determine the size and boundaries of the lot.

(b) Determine number of test samples required in the lot.

(c) Determine the length of the external boundaries of the lot and divide this into units using an origin at one end as zero.

(d) Select random numbers in accordance with Procedure 4.3 to represent the distances along this boundary at which sample sites shall be located.

(e) Locate the sample sites along the boundary at the points represented by the random numbers by physical measurement to within a 0.5 metre radius.
NOTE: Refer to note 4.1.1(f)

4.1.4 Locating Sample Sites on a Time Basis

(a) Determine the period of time that will constitute the lot.

(b) Determine the number of test samples required from the lot.

NOTE: Random sampling in a time frame pre-supposes that production will continue approximately uniformly for the time assumed. If this does not eventuate then an alternative sampling plan will have to be used. This may involve sampling from stockpiles, bins or trucks and abandoning results from the time based samples.

(c) Consider this period of time to be divided into suitable units using a scale starting at zero.

NOTE: The unit of time selected should be a practical size appropriate to the sampling required. In many circumstances a unit of ten minutes should be appropriate and should provide an equal and independent chance of selection. The accuracy of timing sampling need only be approximate provided selection remains unbiased.

(d) Select random numbers to represent the times at which each test sample must be taken after the start of lot production. Select one random number for each test sample required in accordance with Procedure 4.3.

(e) Determine the sampling time for each test sample by physical measurement of time.

4.2 STRATIFIED RANDOM SAMPLING

4.2.1 Locating Sample Sites in a Rectangular Area

The method described in this part of the procedure uses rectangular co-ordinates to locate sample sites in approximately rectangular areas. Although the sampling plan is based on rectangular co-ordinates, the distortion of these co-ordinates necessary for the system to be used on curved sections of road is acceptable.

(a) Determine the width and length of the lot.

(b) Determine the number of test samples required in the lot.

(c) Consider the lot to be divided into sub-lots of approximately equal areas such that there is one sub-lot for each test sample required. Figure 3 provides some examples of how this is conducted.

(d) Devise an imaginary grid of the area of a sub-lot such that any point on the sub-lot can be represented by two numbers, one of which refers to the *x* co-ordinate (width) and the other the *y* co-ordinate (length) of the grid.

NOTE: Refer to note 4.1.1(c).

(e) Select units for the *x* and *y* co-ordinates such that they represent suitable increments of the actual width and length of the sub-lot.

NOTE: Refer to note 4.1.1(d)

(f) Select a pair of random numbers to represent the *x* and *y* co-ordinates of the sample site in accordance with Procedure 4.3.

(g) Repeat Procedures 4.2.1(d) to 4.2.1(f) for each sub-lot.

(h) Locate the sample sites in each sub-lot at the co-ordinates represented by the pairs of random numbers by the physical measurement to within a 0.5 metre radius.
NOTE: Refer to note 4.1.1(f)

4.2.2 Locating Sample Sites in an Area of any Shape

(a) Determine the size and boundaries of the lot.

(b) Determine the number of test samples required from the lot.

(c) Consider the lot to be divided into sub-lots of approximately equal areas.

(d) Consider a sub-lot to be divided into approximately equal size parts that represent suitable increments of the sub-lot area using an imaginary grid or other means.

NOTE: Refer to note 4.1.1(d)

(e) Number the parts consecutively. Figure 2 provides some examples of how this is conducted.

(f) Select random numbers in accordance with Procedure 4.3, within the range used to number the parts, which represent the required number of test samples.

(g) Repeat Procedure 4.2.2(d) to 4.2.2(f) from each sub-lot.

(h) Locate the parts represented by the random numbers selected by physical measurement. The sample sites shall be within the parts so located.

NOTE: Refer to note 4.1.1(f)

4.2.3 Locating Sample Sites in a Stockpile

This method is applicable to stockpiles which are approximately rectangular in plan. Each stockpile shall be regarded as a number of sub-lots of approximately 500 m^3. Sample site selection of other shapes can be selected in a similar manner provided they can be divided into approximately equal volume sub-lots. Sample sites shall be randomly located within these sub-lots or by only considering rectangular portion of the stockpile.

(a) Determine the size and boundaries of the lot.

(b) Determine the number and boundaries of sub-lots and the number of test samples required in the lot.

(c) Determine the length of the external boundaries for each sub-lot and divide this into units using an origin at one end as zero. Figure 4 provides an example of how this is conducted.

(d) Select random numbers in accordance with Procedure 4.3 to represent the distances along the boundary at which sample sites shall be located.

(e) Locate the sample sites along the boundary at the points represented by the random numbers by physical measurement to within a 0.5 metre radius.

NOTE: Refer to note 4.1.1(f)

4.2.4 Locating Sample Sites on a Time Basis

Stratified random sampling from a belt or flowing stream of material is usually most conveniently done on a time basis. This technique is often applicable to aggregate production.

(a) Determine the period of time that will constitute the lot.

(b) Determine the number of test samples required from the lot.

NOTE: Refer to note 4.1.4(b).

(c) Consider this period of time to be divided into sub-lots of approximately equal duration.

NOTE: Refer to note 4.2.1(c).

(d) Consider one sub-lot and divide this into suitable units of time starting at zero.

NOTE: Refer to note 4.1.4(c).

(e) Select a random number in accordance with Procedure 4.3 to represent the period of time at which the test sample must be taken after the start of the production of the sub-lot.

(f) Repeat Procedure 4.2.4(d) to 4.2.4(e) for each sub-lot.

(g) Determine the sampling times for each sub-lot by physical measurement of time.

4.3 SELECTION OF RANDOM NUMBERS

Random numbers may be selected by a variety of techniques provided the appropriate procedure is followed and bias is avoided. When selecting pairs of random numbers it is usual to select all the longitudinal

'*y*' co-ordinates required first then to select the transverse '*x*' co-ordinates.

4.3.1 Random Number Tables

A variety of random number tables are available including versions arranged to suit specific sampling purposes. This procedure describes the use of a simple one-page set of 50 x 50 random numbers, which is included in the method. Alternative random number tables, including multi page sets, may be used however the relevant methods of use for the respective tables must be adhered to.

(a) Place the point of a pencil or other marker blindly on the page of random numbers.

(b) Select the digit nearest the point on this page and the following digit across the row to the right to be the selected row number. If this number is more than 50 subtract 50 from the number and use the remainder as the row number.

(c) Select the next two digits to the right of the digits used as the row number to be the column number. If this number is more than 50 subtract 50 from the number and use the remainder as the column number.

(d) Locate the starting point by going to the row and column selected in Procedure 4.3.1(b) and 4.3.1(c). From the starting point, select and record as many of the following digits across the row to the right as necessary to suit the longitudinal length of the lot e.g. for a lot 500 m long take three digits for each random number and for a lot 1100 m long take four digits for each random number. If the random number so selected is larger than required i.e. greater than the length of the lot, subtract multiples of the length or width until the random number is reduced to a magnitude that is less than the lot length.

(e) Select the next random number by going to the next row in the same column as that of the starting point (i.e. the row numbered one higher). Commencing at this point select and record the required number of digits across the row to the right as necessary.

(f) Proceeding vertically down the starting point column to the next row, repeat Procedure 4.3.1(e) until sufficient random numbers have been obtained for the longitudinal '*y*' co-ordinates. If by running vertically down the column the bottom of the table is reached, go to the top of the next column and continue until as many random numbers as required are obtained. However, if in selecting a series of random numbers by running vertically down the column, the bottom right hand corner of the table is reached; further numbers should be obtained by repeating Procedures 4.3.1(a) to 4.3.1(e).

NOTE: When selecting a series of random numbers it is possible the same number may occur more than once. When this results in the repetitive selection of the same sample site within a lot or sub-lot, only one of the duplicate numbers should be retained and the others discarded and further numbers selected.

(g) Commencing in the same column as that used to select the last longitudinal '*y*' co-ordinate go to the next row down. Select and record as many of the following digits across the row to the right as necessary to suit the transverse width of the lot e.g. for a lot 10 m wide take two digits for each random number.

(h) Select and record the next random number by going to the next row down in the same column as that used in Procedure 4.3.1(g) (i.e. the row numbered one higher) and using the required number of digits across the row to the right as necessary.

(i) Repeat Procedure 4.3.1(h) until sufficient random numbers have been obtained for the transverse '*x*' co-ordinates.

4.3.2 Electronic Random Number Generators

Random numbers can be generated by a variety of suitable electronic calculators and computers. The manufacturer's instructions should be followed when using this source of random numbers. Where a seed is required to generate random numbers it should be varied between applications.

4.3.3 Mechanical Random Number Generators (e.g. Dice)

Random numbers can be selected using any device capable of indication of an unbiased selection of numbers. Manufacturers' instructions should be followed if available.

9 FIGURES AND DRAWINGS

FIGURE 1
RANDOM NUMBER TABLE

Row No.	Column Number									
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50
1	03518	85782	18372	83904	34468	21797	08588	59703	16206	93108
2	64288	74948	82951	87718	89474	42294	49288	35301	26085	13665
	87309	13424	43465	39018	99430	86298	27200	75367	25757	82630
4	82142	04237	60448	42086	14811	25823	98280	09975	71498	86703
5	65192	93302	64133	14728	03853	67402	56153	90413	01923	08277
6	60653	95980	21354	82946	50517	15801	57079	57641	50888	86676
7	18995	89130	56849	04468	66676	56071	90370	96940	41147	54013
8	38012	96929	90862	00178	95994	84532	64599	48869	96004	17639
9	48996	73019	93160	21893	80995	56369	66939	12190	12208	54863
10	35385	76779	84738	35957	89522	30295	34452	77932	09492	79358
11	97648	37452	02543	77667	93734	77593	62651	41696	79808	20785
12	76139	08831	31074	04415	44410	00509	81607	32210	74252	11648
13	33255	13575	35927	83114	03646	22716	03364	39786	05563	30352
14	29661	60936	35831	00594	07919	53694	03043	03414	19205	74662
15	16984	44571	39269	54131	46064	49517	89158	83766	99424	02441
16	29256	57479	75015	00240	53696	11876	42732	33720	82967	50723
17	09938	36362	93450	41076	95484	31660	24125	39296	03917	48128
18	56405	84875	73564	60285	62881	97584	08662	22611	40350	77682
19	89762	12696	46008	01933	87284	41478	24047	64645	80902	51201
20	35941	28686	28211	32712	19782	01562	54712	44097	96635	09910
21	36492	32715	26658	05364	89837	78852	08233	03690	24290	22765
22	94811	40507	18147	74548	47424	55015	55206	36055	18086	17992
23	45819	13174	70474	89336	15141	96756	21887	43577	05346	96934
24	94884	71488	02101	72230	79588	74060	40001	88565	03701	27162
25	37691	84179	44968	72515	05612	14527	30988	51319	72219	14576
26	30632	24054	23580	78766	05266	15051	62227	15311	35211	53065
27	75978	10413	10671	27169	06264	55368	21719	71084	23942	17210
28	99202	79541	46186	71399	06929	33602	51671	85311	84374	42168
29	68179	38582	46420	96158	63827	22869	62876	10410	85315	13029
30	54399	06957	35379	28554	90926	85729	29000	66032	45514	11680
31	10017	99973	63501	40063	73446	96062	86438	05726	35286	94180
32	58868	58405	00475	82443	34822	45918	93014	08104	42403	68562
33	21661	50757	85306	18892	80696	37256	89132	28782	12736	42684
34	74849	63206	15235	95529	01229	05115	44603	71865	85854	47857
35	71407	25122	29907	91737	15592	87883	46392	65219	29482	26699
36	17032	08425	20148	48013	32160	38299	77724	75545	09473	25492
37	71052	48130	01001	99762	97072	33467	28727	11307	23058	21144
38	71929	18009	91278	25535	89620	32960	35592	48857	85406	80665
39	81529	48068	54736	93537	31196	53750	80970	02471	16364	93754
40	20136	12253	55315	64050	80923	83700	87008	07302	19010	79551
41	28274	32324	55583	25081	13992	99357	31100	38434	45649	08488
42	11520	68201	63677	77546	29826	85316	86264	03568	81835	52571
43	54124	38662	68689	24533	09878	26917	60695	32417	06145	88561
44	12711	30877	64178	01220	09104	87449	75916	78403	62790	11468
45	30552	83223	32799	62834	75218	05643	01629	91492	61513	21958
46	85347	91573	61279	19322	91179	60230	99237	54442	73238	69819
47	16801	35036	89355	50680	65607	30899	31602	20509	42057	07402
48	68975	88679	24073	92456	37703	83204	94899	14539	37574	19163
49	86060	42339	45630	96739	81755	65351	35791	63040	67521	50587
50	92603	07319	50710	40460	87944	59202	02105	36490	39023	50476

FIGURE 2
EXAMPLES OF GRID PATTERNS FOR AREAS OF ANY SHAPES

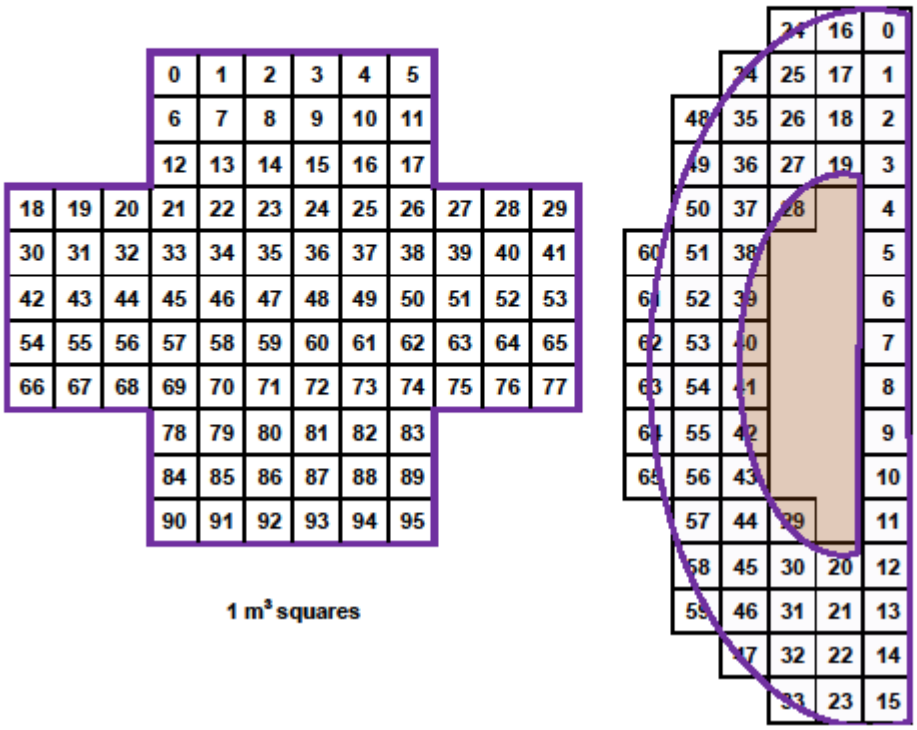
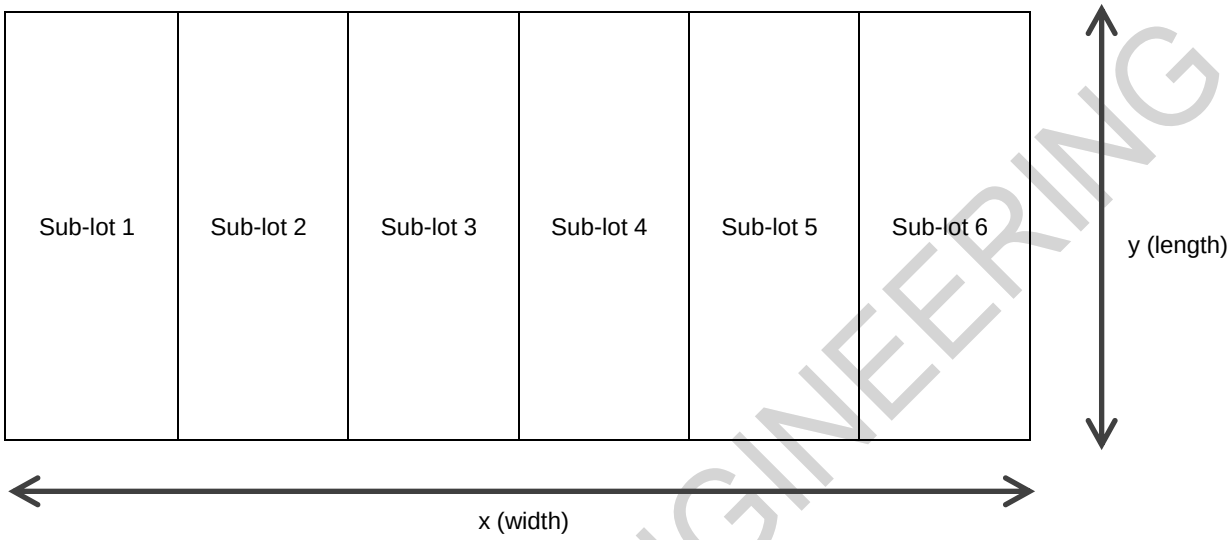


FIGURE 3
EXAMPLES OF STRATIFIED SAMPLING

GRANULAR



ASPHALT

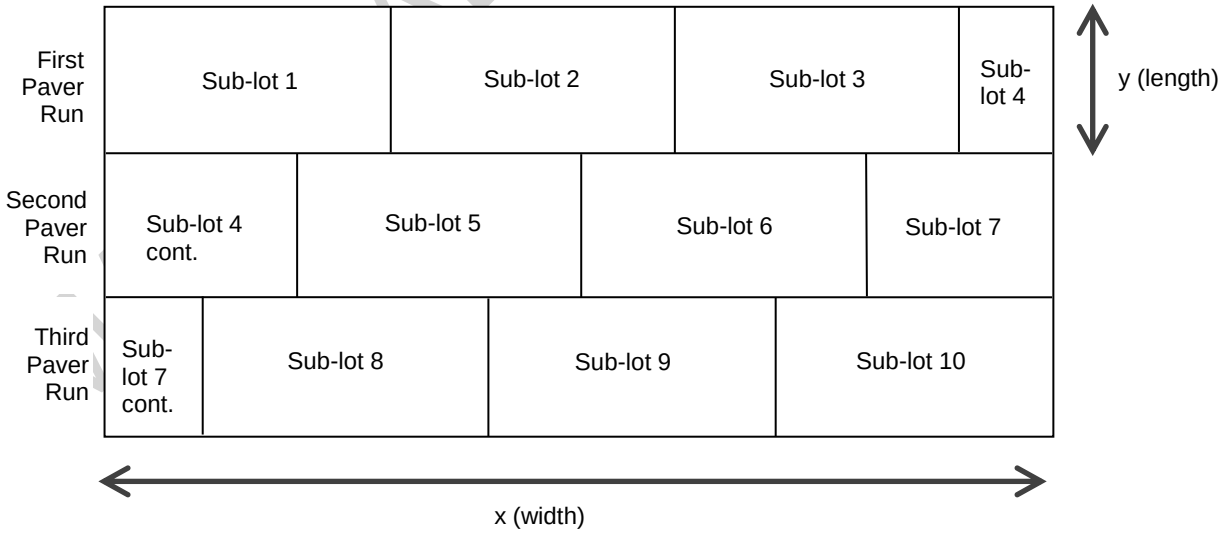
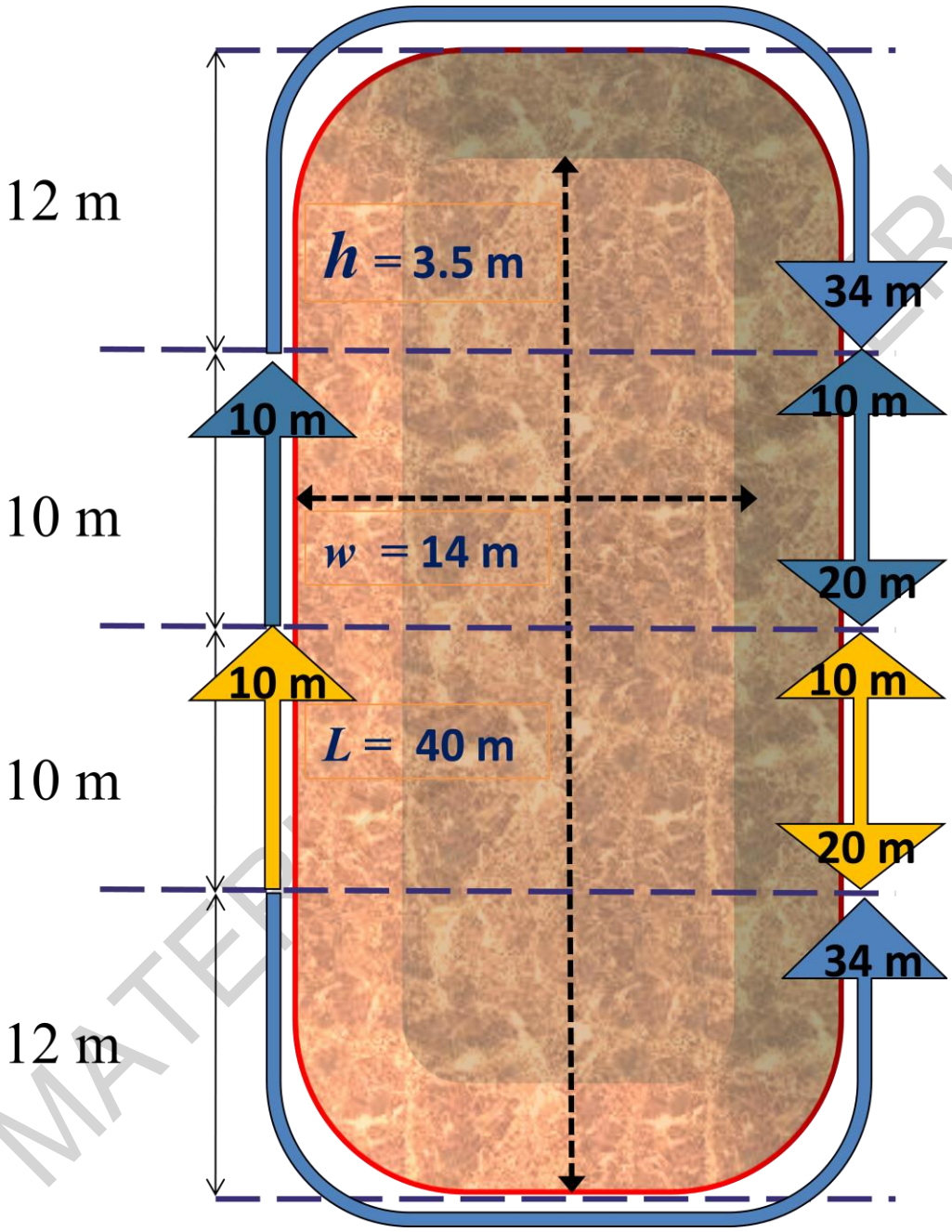


FIGURE 4

EXAMPLE OF DETERMINATION OF THE EXTERNAL LENGTH OF THE BOUNDARIES OF A STOCKPILE



10 ISSUING AUTHORITY

Document Owner	Delegated Custodian
Manager Materials Engineering	Pavements Manager

11 REVISION STATUS RECORD

Page No.	Section	Revision Description / Reference
1	4.1.1 d)	Deleted from note "*To facilitate use of convenient increments it is permissible to randomly locate co-ordinate axes slightly inside lot or sub-lot boundaries."*
2	4.1.1 f)	Deleted from note "*Location of samples sites in a lot or sub-lot need only be to an accuracy of approximately one half the distance represented by the co-ordinate units used or the part size selected."*
2, 3	4.1.1 f), 4.1.3 e), 4.2.1 h), 4.2.2 e)	Added - Physical measurement: "to within a 0.5 metre radius."
3	4.2.1 c)	Added ". Figure 3 provides some examples of how this is conducted."
3	4.2.1 c)	Note deleted "*It is desirable to divide a lot into a sufficient number of sub-lots that only one sample need be taken from each. It is permissible to use a lesser number of sub-lots and to take more than one sample from each provided the sub-lots are of approximately equal size, the same number of samples is taken from each and independence is maintained."*