New BSA Level Points Calculations for Lawn Bowling Greens in South Africa

Background

In the 2010's Ron Cubitt developed spreadsheet applications to determine a point score for the degree of "levelness" of greens which assisted in recording and improving the (out of 30) for the acceptability of levels of a lawn bowls green. This required a "dumpy survey" by taking levels at a spacing of 2 metre intervals on a comparing these levels to a baseline. Typically, on a green of width 36 m and length 36 m, 18x18 = 324 readings were taken and captured in an Excel workbook.

The application first determines a baseline level and then then plots a colour map, showing which points at within between 4 mm above and 4 mm below the baseline was deemed as acceptable, also showing which levels are lower and higher than the acceptable levels.

The number of levels within the tolerance (baseline level ±4 mm) are counted with the BSA Level Point Score based on the percentage (%) of points being acceptable, stated as a value out of 30. A point score of 20/30 was deemed good and a minimum requirement for hosting BSA events. Scores below 10 would indicate serious problems with to green quality due to poor levels when performing renovations or improvements.

At BowlsSA's encouragement the introduction and widespread usage of the Cubitt levels spreadsheets did succeed in bringing attention to the importance of good levels on a green, as well as tracking improvements of levels on a green. It also assists greenkeepers with identifying th location of poor levels (low or high area) for remedial action, as well as to provide some estimate of fill requirements for low-lying areas when using the "PROFILE" worksheet.

The last revision (Revision 5) was released in August 2019 and is currently still in use, but need to be updated with some repairs.

Changes in Revision 6

Some improvements and shortcomings were identified and is addressed in the new revision (Revision 6) which is now issued for use. The following changes are included:

1. Until now, Cubitt has only included the inner area for the level points calculations, so for a 36 m by 36 m green, the levels around the edges (first and last points of any row or column) were ignored and the inner 16x16 levels were used to determine the baseline and the BSA Levels Point Score. This means that the areas next to the ditch (where a lot of bowls is played) was ignored. BSA Level Point Scores will now be calculated for the whole area and this will be used as the national standard in future. (For comparison with previous Level Points Scores, the scores that would have been obtained for the "Old Inner Area" is also calculated.
2. Cubitt used the mode (statistical term describing the value that occurs most frequently in the of the data set) as the baseline for comparison with other levels. The mode will only work when the levels are normally distributed (i.e. looks like a bell-shaped curve when plotted on a histogram). But, when the input levels are not normally distributed, significant errors can be incurred. Technically it is best to **the mean value** (average value) of the data set as the baseline for comparison. This has been remedied in Revision 6.
3. There were some calculation errors in the "fill volumes" calculated that is now corrected in the Profile worksheet. Volumes calculated are still only approximate but now provides a more accurate estimate.

Ron Cubitt's guideline issued with Revision 5 (August 2019) which is still a very good source to be used, especially in explaining how the software is used and operated, as well as to explain the essential elements of surveying/taking levels on a bowls green. It is strongly recommended that inexperienced greenkeepers or persons taking the level first reads Ron's Rev 5 guideline. The reader is referred to his document for areas not specifically addressed in this document. These include:

Page 1:	Foreword and Revisions
Page 2:	Introduction
Page 3:	What is Required
Page 5 - 7:	Leveling Theory, The Dumpy Level, Setting up Dumpy, The Staff,
Page 8 - 10:	Checking a Dumpy, Dumpy Survey of the Green.

These pages were copied and pasted in at the end of this document

The New Excel Workbooks:

Revision 6 replaces all earlier versions and BSA encourages all greenkeepers to adopt the new version as soon as possible. All levels taken after 31 December 2026 must use the new version.

Levels can now be taken at 2 m or 3 m intervals on a green. The 2m intervals correspond to the original Bowls SA 2 m spaced intervals, resulting in a fine grid. World Bowls uses a coarser 3m interval spacing between level data points, so there are also 3 m interval versions which results in coarser grid. At this stage the greenkeeper can decide which one to use – the finer grid (2m intervals) takes longer because it uses more data points, but this finer grid make it easier to locate and pin-point areas needing to be addressed. The coarser (3m spaced grid) is considerably quicker though!

There are five Excel workbooks to cater for green sizes ranging from 31x31m to 41x41m:

For the 2m interval spacing (Version 6A*) we have

- The 32m version caters for green dimensions 31 to 33 m with a 16 x 16 grid
- The 34m version caters for green dimensions 33 to 35 m with a 17 x 17 grid
- The 36m version caters for green dimensions 35 to 37 m with a 18 x 18 grid
- The 38m version caters for green dimensions 37 to 39 m with a 19 x 19 grid
- The 40m version caters for green dimensions 39 to 41 m with a 20 x 20 grid

For the 3m interval spacing (Version 6X*) we have

- A version that caters for green dimensions 31 to 35m with a 11 x 11 grid
- A version that caters for green dimensions 35 to 37m with a 12 x 12 grid
- A version that caters for green dimensions 37 to 40m with a 13 x 13 grid

The asterisk (*) in the Version number shows the current version – to reflect when updates are made.

Select the version that best fits your preferences and green size, download and use accordingly.

The acceptable tolerance (deviation from the baseline) can also be chosen to be set at the current ±4mm used by Bowls SA for Level Points Score calculations, or set to a stricter ±3 mm as used by World Bowls. For current **Bowls South Arica Level Points Scores, we will still use the 4 mm tolerance**.

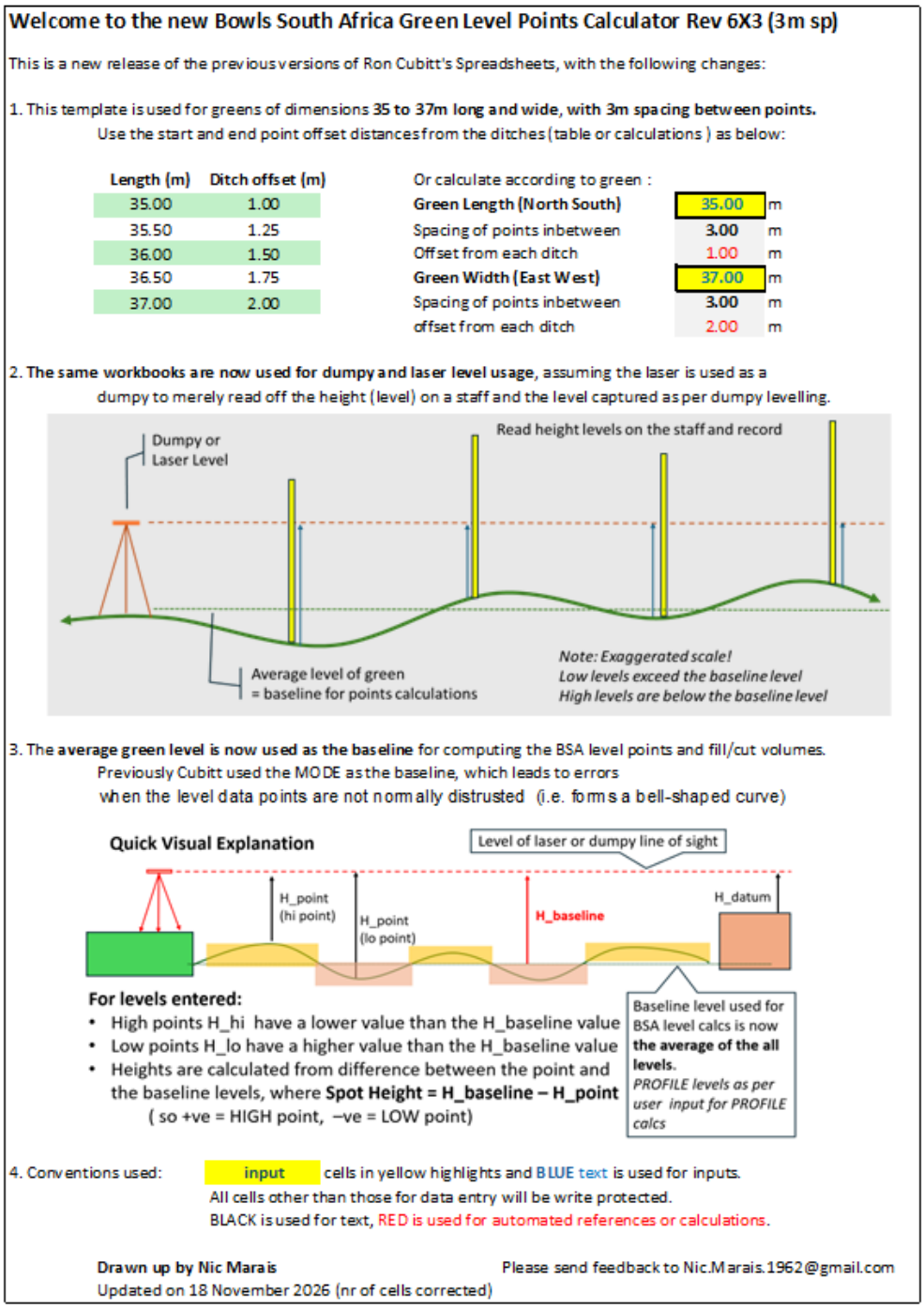
Note that the **same workbook is used for both dumpy levels and laser levels** because it is assumed the laser level is used similarly to the dumpy level and the level that the laser makes on the staff is captured.

The worksheets within each workbook are write/copy protected and users can only insert data (numbers or text) in cells that are highlight in YELLOW. Where inputs are repeated (titles etc) they are displayed in RED text or numbers.

In Revision 6, the Excel workbooks have six worksheets that performs specific tasks as shown below:

1. **INTRO** – This worksheet introduces Revision 6 with some explanatory notes. It also contains a table showing the offset from the ditches for the first and last level position for the range of sizes of the green – or use the calculations by inserting the actual length/width of the green.

   User Inputs: Enter the green length and green width in the respective two yellow cells, and the offset from the ditch is calculated.



Welcome to the new Bowls South Africa Green Level Points Calculator Rev 6X3 (3m sp)

This is a new release of the previous versions of Ron Cubitt's Spreadsheets, with the following changes:

1. This template is used for greens of dimensions **35 to 37m long and wide, with 3m spacing between points.**
   Use the start and end point offset distances from the ditches (table or calculations) as below:

Length (m)	Ditch offset (m)
35.00	1.00
35.50	1.25
36.00	1.50
36.50	1.75
37.00	2.00

Or calculate according to green :

Green Length (North South)	35.00	m
Spacing of points inbetween	3.00	m
Offset from each ditch	1.00	m
Green Width (East West)	37.00	m
Spacing of points inbetween	3.00	m
offset from each ditch	2.00	m

2. **The same workbooks are now used for dumpy and laser level usage**, assuming the laser is used as a dumpy to merely read off the height (level) on a staff and the level captured as per dumpy levelling.

3. The **average green level is now used as the baseline** for computing the BSA level points and fill/cut volumes.
   Previously Cubitt used the MODE as the baseline, which leads to errors when the level data points are not normally distrusted (i.e. forms a bell-shaped curve)

Quick Visual Explanation

For levels entered:

- High points H_hi have a lower value than the H_baseline value
- Low points H_lo have a higher value than the H_baseline value
- Heights are calculated from difference between the point and the baseline levels, where **Spot Height = H_baseline – H_point**
  (so +ve = HIGH point, –ve = LOW point)

Baseline level used for BSA level calcs is now **the average of the all levels.**
PROFILE levels as per user input for PROFILE calcs

4. Conventions used: input cells in yellow highlights and BLUE text is used for inputs.
   All cells other than those for data entry will be write protected.
   BLACK is used for text, RED is used for automated references or calculations.

Drawn up by Nic Marais Please send feedback to Nic.Marais.1962@gmail.com
Updated on 18 November 2026 (nr of cells corrected)

2. INPUT – This worksheet captures all the input data for the subsequent level points calculations.

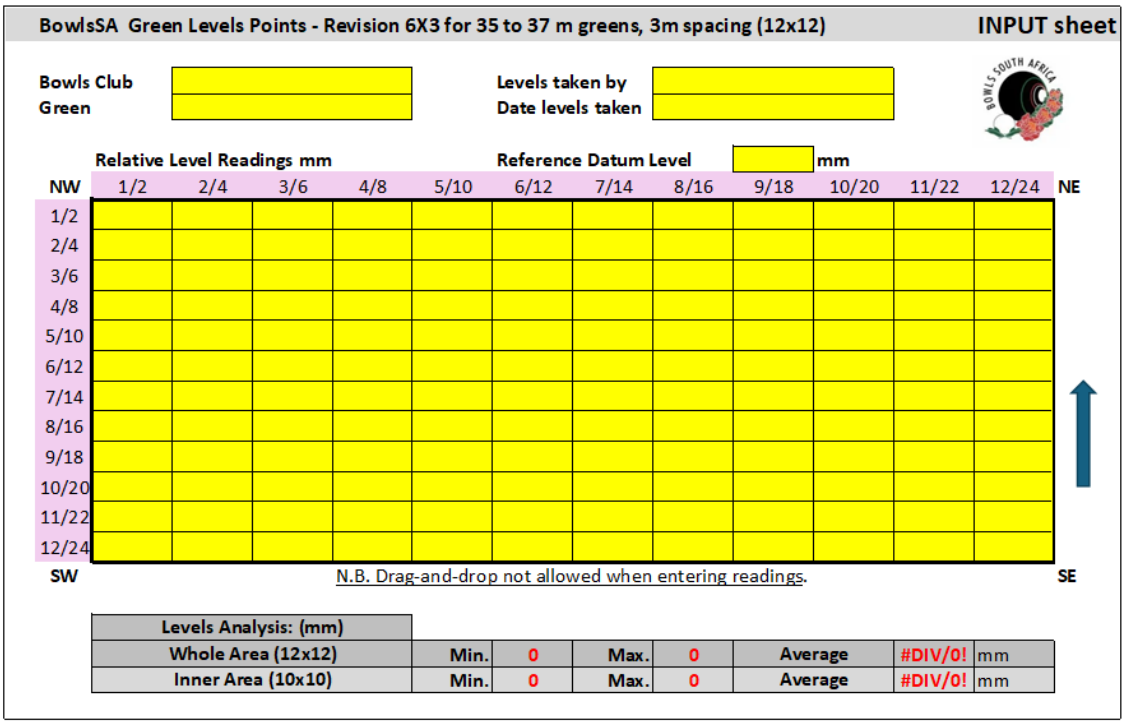
User Inputs:

Enter the descriptive data as required (Bowls club, Green, Surveyor, Date taken, the Datum (as a future reference point)).

Then enter the levels taken on the green strictly in the order and sequence as required.

The worksheet then displays the maximum and minimum level entered, as well as the average level for both the whole area and the inner area for information purposes.

Example of new INPUT worksheet (unpopulated)



BowlsSA Green Levels Points - Revision 6X3 for 35 to 37 m greens, 3m spacing (12x12) — INPUT sheet

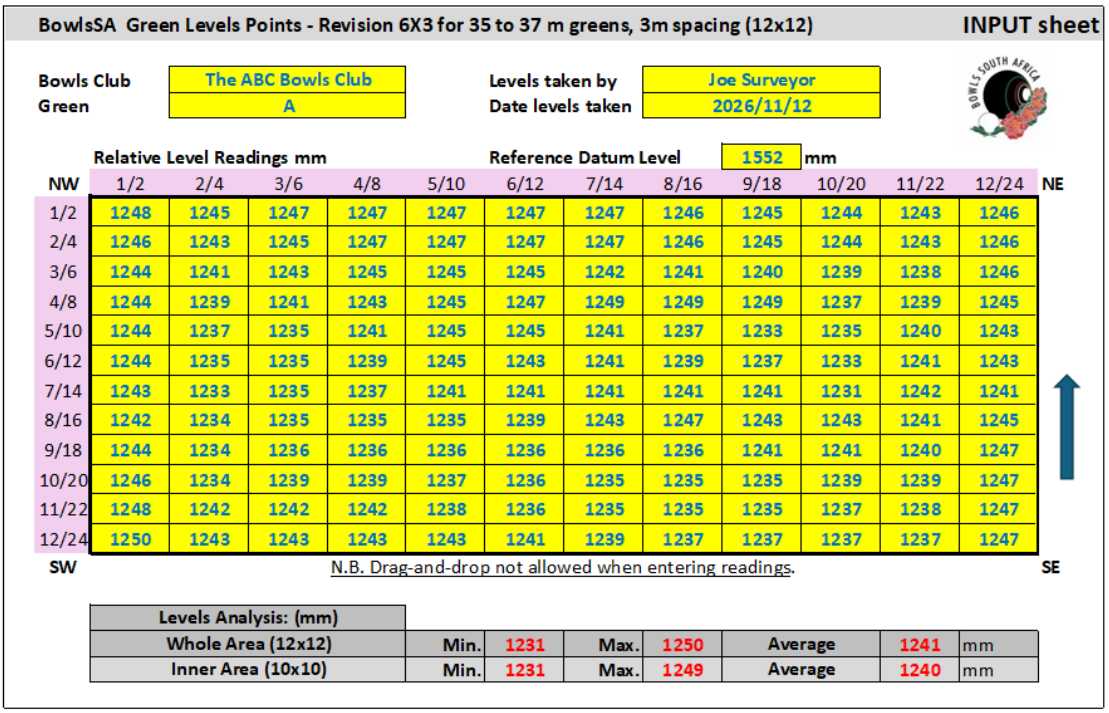
Bowls Club | Levels taken by
Green | Date levels taken

Relative Level Readings mm — Reference Datum Level ____ mm

NW	1/2	2/4	3/6	4/8	5/10	6/12	7/14	8/16	9/18	10/20	11/22	12/24	NE
1/2													
2/4													
3/6													
4/8													
5/10													
6/12													
7/14													
8/16													
9/18													
10/20													
11/22													
12/24													
SW	N.B. Drag-and-drop not allowed when entering readings.												SE

Levels Analysis: (mm)							
Whole Area (12x12)	Min.	0	Max.	0	Average	#DIV/0!	mm
Inner Area (10x10)	Min.	0	Max.	0	Average	#DIV/0!	mm

Example of completed worksheet (populated)



BowlsSA Green Levels Points - Revision 6X3 for 35 to 37 m greens, 3m spacing (12x12) — INPUT sheet

Bowls Club: The ABC Bowls Club | Levels taken by: Joe Surveyor
Green: A | Date levels taken: 2026/11/12

Relative Level Readings mm — Reference Datum Level 1552 mm

NW	1/2	2/4	3/6	4/8	5/10	6/12	7/14	8/16	9/18	10/20	11/22	12/24	NE
1/2	1248	1245	1247	1247	1247	1247	1247	1246	1245	1244	1243	1246	
2/4	1246	1243	1245	1247	1247	1247	1247	1246	1245	1244	1243	1246	
3/6	1244	1241	1243	1245	1245	1245	1242	1241	1240	1239	1238	1246	
4/8	1244	1239	1241	1243	1245	1247	1249	1249	1249	1237	1239	1245	
5/10	1244	1237	1235	1241	1245	1245	1241	1237	1233	1235	1240	1243	
6/12	1244	1235	1235	1239	1245	1243	1241	1239	1237	1233	1241	1243	
7/14	1243	1233	1235	1237	1241	1241	1241	1241	1241	1231	1242	1241	
8/16	1242	1234	1235	1235	1235	1239	1243	1247	1243	1243	1241	1245	
9/18	1244	1234	1236	1236	1236	1236	1236	1236	1241	1241	1240	1247	
10/20	1246	1234	1239	1239	1237	1236	1235	1235	1235	1239	1239	1247	
11/22	1248	1242	1242	1242	1238	1236	1235	1235	1235	1237	1238	1247	
12/24	1250	1243	1243	1243	1243	1241	1239	1237	1237	1237	1237	1247	
SW	N.B. Drag-and-drop not allowed when entering readings.												SE

Levels Analysis: (mm)							
Whole Area (12x12)	Min.	1231	Max.	1250	Average	1241	mm
Inner Area (10x10)	Min.	1231	Max.	1249	Average	1240	mm

3. **BSA LEVEL POINTS** – This worksheet **automatically calculates** the BSA Level Point for the **whole area**, and summary information such the highest and lowest levels, as well as baseline (average) level. It also produces the colour map showing areas outside the acceptable areas (i.e. those below, within or above the baseline ± the tolerance), showing how many millimetres the points differ from the baseline.

   User Inputs: The default tolerance is set at 4 mm for Bowls SA greens. However, the user can change this tolerance to smaller or larger values. Note the Bowls SA standard requirement is 4mm and this value will be used for BSA Level Scores. (The World Bowls requirement is 3 mm)

   Print this page as a record of the current Levels for your own purposes and a copy will be for District and National green inspections.

Example below:

BowlsSA Green Levels Points - Revision 6X3 for 35 to 37 m greens, 3m spacing (12x12) — **BSA POINTS**

Bowls Club	The ABC Bowls Club	Levels taken by	Joe Surveyor
Green	A	Date of Levels Taken	2026/11/12

Set Tolerance (Tol.) to ± 4 mm Index: LOW <-Tol. OK ± Tol. HIGH >Tol.

	NW											NE
1/2	-7	-4	-6	-6	-6	-6	-6	-5	-4	-3	-2	-5
2/4	-5	-2	-4	-6	-6	-6	-6	-5	-4	-3	-2	-5
3/6	-3	0	-2	-4	-4	-4	-1	0	1	2	3	-5
4/8	-3	2	0	-2	-4	-6	-8	-8	-8	4	2	-4
5/10	-3	4	6	0	-4	-4	0	4	8	6	1	-2
6/12	-3	6	6	2	-4	-2	0	2	4	8	0	-2
7/14	-2	8	6	4	0	0	0	0	0	10	-1	0
8/16	-1	7	6	6	6	2	-2	-6	-2	-2	0	-4
9/18	-3	7	5	5	5	5	5	5	0	0	1	-6
10/20	-5	7	2	2	4	5	6	6	6	2	2	-6
11/22	-7	-1	-1	-1	3	5	6	6	6	4	3	-6
12/24	-9	-2	-2	-2	-2	0	2	4	4	4	4	-6
	SW	1/2	2/4	3/6	4/8	5/10	6/12	7/14	8/16	9/18	10/20	11/22	12/24	SE

Baseline	1241 mm	Level Points	87	60%	LOW Points	28	19%
					HIGH Points	29	20%

BSA Level Points calculated from baseline ± 4 mm (out of 30) for WHOLE AREA — **18**

4. **Old Inner Area** – This worksheet automatically calculates the BSA Level Point for the **inner area** (perimeter readings are excluded so that it can be **used for historical comparison to previous Cubitt scores**. For this inner area, it also contains a summary information such the highest and lowest levels, as well as baseline (average) level.

   User Inputs: The default tolerance is set at 4 mm for Bowls SA greens. However, the user can change this tolerance to smaller or larger values. Note the Bowls SA standard requirement is 4mm and this value will be used for BSA Level Scores. (The World Bowls requirement is 3 mm)

   Print this page as a record of the current levels and historical BSA Point scores for comparing and tracking improvements from previous levels taken. BSA will be phasing out the inner area point score and working with the whole area Level Point Scores in the future.

Example below

BowlsSA Green Levels Points - Revision 6X3 for 35 to 37 m greens, 3m spacing (12x12) — **Inner Points**

Bowls Club	The ABC Bowls Club	Levels taken by	Joe Surveyor
Green	A	Date of Levels Taken	2026/11/12

Set Tolerance (Tol.) to ± 4 mm Index: LOW <-Tol. OK ± Tol. HIGH >Tol.

	NW								NE	
1/2										
2/4	-3	-5	-7	-7	-7	-7	-6	-5	-4	-3
3/6	-1	-3	-5	-5	-5	-2	-1	0	1	2
4/8	1	-1	-3	-5	-7	-9	-9	-9	3	1
5/10	3	5	-1	-5	-5	-1	3	7	5	0
6/12	5	5	1	-5	-3	-1	1	3	7	-1
7/14	7	5	3	-1	-1	-1	-1	-1	9	-2
8/16	6	5	5	5	1	-3	-7	-3	-3	-1
9/18	6	4	4	4	4	4	4	-1	-1	0
10/20	6	1	1	3	4	5	5	5	1	1
11/22	-2	-2	-2	2	4	5	5	5	3	2
12/24										
SW	1/2	2/4	3/6	4/8	5/10	6/12	7/14	8/16	9/18	10/20	11/22	12/24	SE

Baseline	1240 mm	Level Points	60	60%	
				LOW Points	19	19%
				HIGH Points	21	21%

BSA Level Points calculated from baseline ± 4 mm (out of 30) for INNER AREA — **18**

5. **PROFILE** – This worksheet analyses the effects of levelling green to the user specified new baseline level value. It calculates the maximum cut and fill depths, percentage of areas requiring cut and fill and estimates the volumes of fill to be added in low areas (fill) and the volumes of material to be removed from high areas (cut).

   User Inputs:

   Enter the SET new base level to the value that you plan as the new average level of the green, as well as the width and length of the green for volume calculations.

   Optimal new base line levels can be determined by trial and error to minimise, cut, fill or vlomues as desired.

   A colour map, showing offset from the new base level is produced, with the areas **within ±1 mm of the new baseline level shown in green,** with lower values shown in light red and higher areas shown in light brown.

Example below:

BowlsSA Green Levels Points - Revision 6X3 for 35 to 37 m greens, 3m spacing (12x12) **PROFILE sheet**

Bowls Club	The ABC Bowls Club	Levels taken by	Joe Surveyor
Green	A	Date of Levels Taken	2026/11/12

SET new base level to	1238	mm

Average Level	1241	mm
Highest Point	1231	mm
Lowest Point	1250	mm

Index: LOW | Level | HIGH

NW												NE
1/2	-10	-7	-9	-9	-9	-9	-9	-8	-7	-6	-5	-8
2/4	-8	-5	-7	-9	-9	-9	-9	-8	-7	-6	-5	-8
3/6	-6	-3	-5	-7	-7	-7	-4	-3	-2	-1	0	-8
4/8	-6	-1	-3	-5	-7	-9	-11	-11	-11	1	-1	-7
5/10	-6	1	3	-3	-7	-7	-3	1	5	3	-2	-5
6/12	-6	3	3	-1	-7	-5	-3	-1	1	5	-3	-5
7/14	-5	5	3	1	-3	-3	-3	-3	-3	7	-4	-3
8/16	-4	4	3	3	3	-1	-5	-9	-5	-5	-3	-7
9/18	-6	4	2	2	2	2	2	2	-3	-3	-2	-9
10/20	-8	4	-1	-1	1	2	3	3	3	-1	-1	-9
11/22	-10	-4	-4	-4	0	2	3	3	3	1	0	-9
12/24	-12	-5	-5	-5	-5	-3	-1	1	1	1	1	-9
SW	1/2	2/4	3/6	4/8	5/10	6/12	7/14	8/16	9/18	10/20	11/22	12/24 SE

NEW GREEN LEVEL (mm)	1238	Maximum Cut (mm)	7	Maximum Fill (mm)	-12
Area within ± 1mm	17%	HIGH Area Requiring Cut	20%	LOW Area Requiring Fill	63%

For Volume Calculations

Green Length	36.00	m	Green Area	1296.0	m2	Estimated Fill Volume	5.05	m3
Green Width	36.00	m	Block Area	9.00	m2	Estimate Cut/Scarify Vol.	0.93	m3

6. RecordSheet – This worksheet is set up to print a sheet for recording levels for the green size selected.

User Inputs:
No user inputs are required. Just print a copy to use as a recording sheet while performing the level survey.

Example below:

BowlsSA Green Levels Points - Revision 6X3 for 35 to 37 m greens, 3m spacing (12x12) **RecordSheet**

Bowls Club		Levels taken by		Datum (mm)			
Green		Date Levels Taken					

NW	1/2	2/4	3/6	4/8	5/10	6/12	7/14	8/16	9/18	10/20	11/22	12/24	NE
1/2													
2/4													
3/6													
4/8													
5/10													
6/12													
7/14													
8/16													
9/18													
10/20													
11/22													
12/24													
SW													SE

Document prepared by **Nic Marais**

Updated and Revised 20 November 2026

Please report errors and improvements to me at Nic.Marais.1962@gmail.com

Below are extracts from Cubitt's guideline for Revision 5 which give useful explanations of the survey procedures and setting up the Leveling exercise.

Creating a Bowling Green Profile using a Dumpy Level and Excel

Foreword

At a BSA Greens Standing Committee Meeting at Hillcrest in November 2017, the Cubitt Excel Workbook was discussed and approved as part of the Level Two syllabus and recommended for implementation by all BSA Districts.

The Cubitt Excel Workbook is prepared for simplifying procedures in arranging level grids and leveling procedures for Bowling Greens varying in size from 35 meters to 41 meters.

The Cubitt Excel Workbook introduces the following advantages:

- Standardize the presentations of Level Grids with 2 – meter grid centers.
- Simplify filing the docs for future reference to follow a history trend.
- Does all the level calculations.
- Calculates BSA Level Points and creates a printable grid showing variations of green's levels.
- Creates a printable profile of green that is used to plan the levelling exercise.

When BSA GSC inspect Greens for National Competitions the Clubs will be expected as, a prerequisite to the Inspection, to make available to the Inspectors the spreadsheet "BSA Level Points" for the greens being inspected.

Cubitt Level Program is for the sole use of BSA Greens Standing Committee and not to be circulated to outside interests. The program will be forwarded to all BSA District Clubs and is also available from any member of the BSA Greens Standing Committee.

The program workbooks are password protected, please do not attempt to make any changes to this program.

BSA Greens Standing Committee

Revisions

There have been several Revisions of the documentation and Excel workbooks since the initial workshop. The reasons being improved/additional documentation; new spreadsheet – "BSA Level Points"; use of Lazer levels required new Excel workbooks; improvements to spreadsheets – "BSA Level Points" / "Profile" this revision. All the changes are compatible with earlier versions i.e. readings from earlier surveys can be copied into latest versions of workbooks.

Creating a Bowling Green Profile using a Dumpy Level and Excel

Introduction

Although most clubs have access to a dumpy level, it is not usual for clubs to survey the levels of a green. The dumpy is usually used to do spot checks of levels across a green. By definition a survey "records the features of an area (green) to produce a plan (profile) of the area". For a survey; dumpy readings are taken, at predefined points, every 2 meters over the green. The problem with this is the number of readings; 324 (36x36 meter green) which are merely numbers. The relative levels of the green must be calculated from the dumpy readings; this is not a trivial exercise and is prone to errors. It is also difficult to manually produce an easy to use plan (profile) of the green surveyed.

Initial surveys that I did on the Garden route were done this way. To get around these problems Microsoft Excel[1] (spreadsheets[3] mirror a surveyed green) and the PC for speed of calculations were used to create an Excel workbook[2] that does calculations and creates an easy to use plan (profile). Surveys using this Excel workbook to process data have been done on the Garden route since 2008/2009.

In 2014 a workshop was held in George, under the auspices of Eden Bowls, so that clubs could acquire the skills in house. In 2016 a workshop was held in Cape Town, under the auspices of Western Province Bowls, for clubs in that area. These workshops were coordinated by Vlam Basson (George) and Bill McCarthy (Cape Town) both members of BSA Greens Standing Committee.

Originally, I was only user of the Excel workbook, so no need for notes. Since the workshops clubs on the Garden route, in Cape Town, the Boland, Eastern Cape, Border etc. are using the Excel workbook, so need for a write up and additional testing. Both Vlam Basson and Bill McCarthy were a great help with proof reading as well as testing.

Revision 4 added a spreadsheet "BSA Level Points". This came about after discussing BSA Level Points test with Bill McCarthy and Vlam Basson. All the data needed for this test is in the dumpy survey readings, calculations to test levels as per BSA were added to the workbook.

Revision 5 is a better presentation/analyses of the survey data; it is fully compatible with revision 4 and earlier versions i.e. readings from earlier surveys can be copied into Revision 5 workbooks. The Excel workbooks are:

- For Dumpy Level "Cubitt's Green 36 Dumpy Levels - August 2019 Revision 5" / "Cubitt's Green 38 Dumpy Levels - August 2019 Revision 5" / "Cubitt's Green 40 Dumpy Levels - August 2019 Revision 5"
- For Lazer Level "Cubitt's Green 36 Lazer Levels - August 2019 Revision 5" / "Cubitt's Green 38 Lazer Levels - August 2019 Revision 5"

[1] Excel a component of MS Office; can manipulate, analyze and perform calculations on large amounts of data, in spreadsheets, quickly and efficiently.
[2] Workbook an Excel file that has one or more spreadsheets.
[3] Spreadsheet a digital document in which data is arranged in rows and columns of a grid

Creating a Bowling Green Profile using a Dumpy Level and Excel

This write up is available as a PDF "Cubitt's Green Levels Write Up - August 2019 Revision 5".

Examples in the write up refer to 18x18 or 36 meter green, however, green sizes in range 35 to 41 meters are catered for in the different versions of the Excel workbook. The Excel workbooks have three programmed spreadsheets; namely "**Input**", "**BSA Level Points**" and "**Profile**". These Excel workbooks and write up are distributed by way of copying onto memory sticks or email attachments.

What started out as a request to help green keepers learn to use a dumpy level has evolved through the interest of Vlam Basson (Eden Bowls) and Bill McCarthy (Western Province Bowls) into a useful aid to green keepers.

Ron Cubitt

What is Required

N.B. To survey a green a club will need:

- Access to a PC which has Microsoft Excel and Adobe installed.
- The correct Excel workbook for the exercise i.e. "Cubitt's Green 36 Dumpy Levels - August 2019 Revision 5" is for green 34 to 37 meters using a Dumpy level; "Cubitt's Green 36 Lazer Levels - August 2019 Revision 5" is for green 34 to 37 meters using a Lazer level.
- Someone with basic PC skill; open a spreadsheet, enter data, print a spreadsheet, save a spreadsheet etc.
- Basic understanding of levels – page 5.
- Access to a working dumpy and staff; how to check a dumpy – page 8.
- Ability to setup a dumpy and take readings from a staff – pages 6/7.
- To have set up a datum; a permanent fixed point ideally placed in ditch at North/West corner of green. The datum is used to compare levels on a green over time – all levels are relative to the datum. If the tripod is disturbed or bad weather interrupts a survey, the dumpy can be set up again and readings adjusted by comparing readings to the datum.
- Using non-stretch rope/twine make up a cord with marks to indicate the points at which dumpy readings must be taken. Bowling green is visualized as a matrix of 2 meter blocks a dumpy reading taken in each block. For 36 meter green – 18x18 matrix:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

For 38 meter green – 19x19 matrix:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Creating a Bowling Green Profile using a Dumpy Level and Excel

For both 36 meter and 38 meter greens the first mark is 1 meter from the ditch board then marks are at 2 meter intervals.

It is unlikely that bowling green will be exactly 36x36 or 38x38 meters so measurement to first mark is adjusted to allow for different green size.

For 18x18 matrix use formula (((width of green)-36)/2 + 1) = meters to first mark on cord examples:

- 34.8x34.8 green (34.8-36.0)/2+1=0.4 first mark to beginning of cord.
- 35.6x35.6 green (35.6-36.0)/2+1=0.8 meters to first mark on cord.
- 36.0x36.0 green (36.0-36.0)/2+1=1.0 meters to first mark on cord.

For 19x19 matrix use formula (((width of green)-38)/2 + 1) = meters to first mark on cord examples:

- 38.0x38.0 green (38.0-38.0)/2+1=1.0 meters to first mark on cord.
- 38.7x38.7 green (38.7-38.0)/2+1=1.35 meters to first mark on cord
- 39.0x39.0 green (39.0-38.0)/2+1=1.5 meters to first mark on cord.

- Two 2 meters long canes – used to move cord across green.
- The discipline to follow process for survey exactly as explained in this document.
- Survey log for the green being surveyed – print of page 17, 18 or 19.
- Time to take dumpy readings; experienced + – 1hr30mn beginner + – 2hr.
- **Readings to nearest millimeter – four digits – no decimal point. Readings can't be to nearest 5 mm.**
- Willing members who are prepared to spend a morning assisting.
- Time to enter readings into "Input" spreadsheet + – 30mn.
- Time to do calculations – instantaneous!!!!

The user does not have to understand Excel beyond opening a workbook and entering data. However, the survey must be done exactly as specified in the write up. Any variations will result in incorrect processing and output.

Creating a Bowling Green Profile using a Dumpy Level and Excel

Leveling Theory

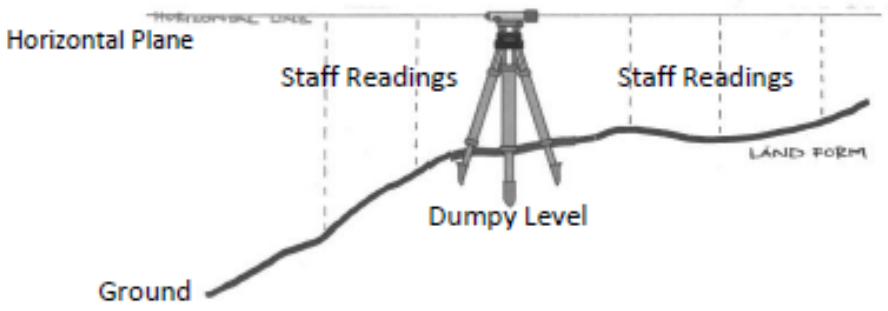
The basic principle used to determine levels is very simple. A horizontal line is imagined in relation to the ground; this line is more like a plane which can go in any direction at the same level. By calculating the differences in elevation from the ground to the horizontal plane relative levels of points are established.



The instrument commonly used to do this is a dumpy level and staff. Although the dumpy level is robust, it is a sensitive instrument so take care how you handle it. Using a dumpy level and staff requires a certain amount of skill, but you will, with practice, soon acquire this skill.



Once the dumpy is set up and leveled, the horizontal plane is established. The staff can now be used to take readings at different points on the ground; the difference between these readings is the relative heights of the points surveyed. The point with highest elevation has smallest reading and point with lowest elevation has biggest reading. The differences between these readings allow the ground contour to be understood and drawn.



Creating a Bowling Green Profile using a Dumpy Level and Excel

The Dumpy Level

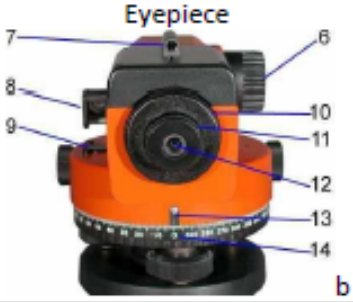
<u>Dumpy Level Components</u>

1. Footplate – attaches dumpy to tripod
2. Leveling Screws – to level dumpy
3. Ignore
4. Direction Control – to line up staff
5. Object lens
6. Image Focus Knob – to focus staff
7. Gun Sight – for pointing
8. Prism to see bubble level
9. Leveling Bubble – indicates level
10. Ignore
11. Eyepiece focus screw
12. Eyepiece – to look through
13. Ignore

Front



Eyepiece



b

<u>Setting up Dumpy</u>

Take care when setting up dumpy, work carefully and methodically. Do not remove dumpy from case until tripod is set up.

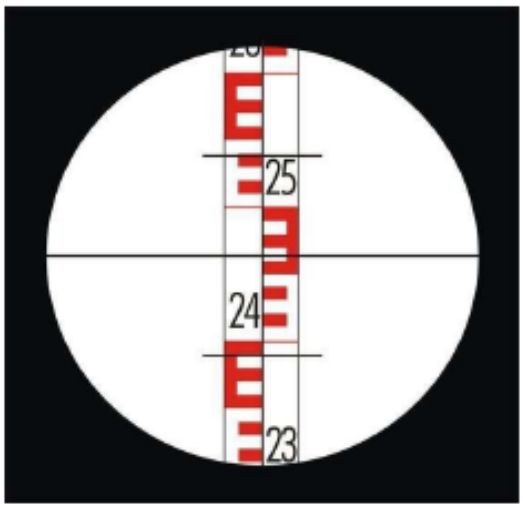
1. Open tripod and extend legs to desired length, so that dumpy will be at eye level, tighten leg clamps. Place tripod in position where it will be stationed, balance legs and get top of tripod near level. Check that legs are in suitable position for taking readings, press legs firmly into ground.
2. Remove dumpy from case and attach to tripod using large screw in tripod, make sure dumpy is firmly attached.
3. Level dumpy using bubble; turn dumpy parallel to 2 foot screws, adjust level using these 2 foot screws, turn dumpy 90^0 degrees and level using 3rd foot screw. Bubble should be in canter of circle – if not repeat process until dumpy is level.
4. Look into eyepiece and focus cross hairs using adjusting dial.
5. Test direction controls and use of gun sight for pointing.
6. Test image focus controls.

Creating a Bowling Green Profile using a Dumpy Level and Excel

The Staff

The staff an aluminum rod is graduated in 10mm intervals and has a bubble level on the back. It has sections and is adjusted by telescoping sections inside each other.

- Every 100mm is numbered, the bottom half (50mm) is alternate red/black bands, the top half (50mm) looks like an **E.**
- The staff is held vertically at the point being checked, if hiring a staff get one with a bubble on the back.
- Readings can be visually interpolated to 1mm i.e. half the marking is 5mm, quarter 2/3mm etc.



Reading the Staff

1. Open staff to required length; make sure sections are firmly locked.
2. Make sure staff is held upright – check bubble level on back of staff.
3. The dumpy telescope allows readings to be made over a long distance. Focus the telescope cross hairs first using the eyepiece control.
4. Point dumpy at staff using the gun sight on the telescope.
5. Focus on the staff using the focus on the side and the horizon direction control.
6. Read off horizontal cross hair on the staff
7. **Readings are in millimeters – four digits – no decimal point.**
8. Record readings on a survey log sheet.
9. Example staff reading showed in this picture is 2464 mm

Remember that every time the dumpy is setup it will be at a different height; if readings need to be on the same base level, reading to a fixed datum must be taken every time dumpy is set up.

Creating a Bowling Green Profile using a Dumpy Level and Excel

Checking a Dumpy Level

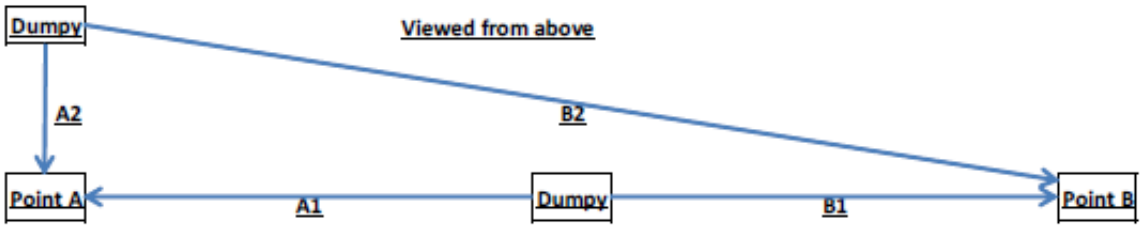
Checking the bubble level

Setup and level the dumpy as outlined above. Rotate the dumpy so that the bubble level is above one of the adjustment wheels and check that the bubble is still within the circle. Repeat process for all adjustment wheels. Provided the bubble stays within the circle when located over the adjustment wheels then the bubble level is sufficiently calibrated.

Checking the horizontal

Set up the dumpy halfway between two fixed points A and B; distance between these points + – width of green. Take readings A1 and B1 to staff at points A and B; move dumpy so that it is about 2m from point A and take readings A2 and B2 to staff at points A and B.

Allowing 1 or 2 mms for reading errors the difference between A1/B1 must equal the difference between A2/B2; if it does not the dumpy needs recalibration.



Dumpy Survey of Green

The definition of a survey is "To record the features of an area (green) to produce a plan (profile) of the area". To create an accurate profile, readings are taken at 324 predefined points over the green; predefined so that they can be plotted on the profile. Each point therefore has elevation as well as position – this is assumed in spreadsheet calculations.

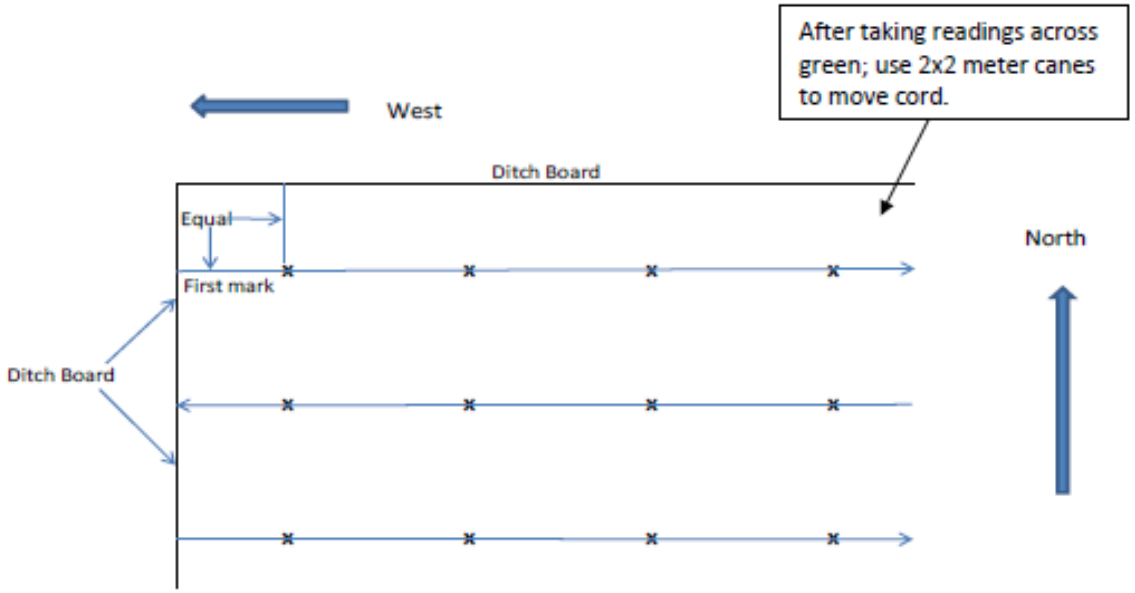
Elevation of points on the green are measured by dumpy readings – for accurate levels take accurate readings:

- Check that dumpy level and staff are in good working order.
- All readings in millimeters – four digits – no decimal point.
- Hold staff as vertically as possible – if available use staff with bubble level.

Position on the green is established by the survey process. The green is visualized as an 18x18 matrix of 2x2 meter squares; the matrix is tied to North/West corner of the green. A dumpy reading is taken in each square; the row and column number accurately position the dumpy reading on the green.

Creating a Bowling Green Profile using a Dumpy Level and Excel

The diagram below shows how the matrix is set out on the green starting at North/West corner.



For the survey you will need; a clipboard and pen, a copy of "Survey Log" for recording readings – page 17 or 18, the cord for taking readings, the two canes for moving cord, plus three people; one to read and record levels, one to hold the staff and one to assist with setting up, moving cord, holding staff etc.

1. Choose a position for the dumpy with a good line of site to the datum and green.
2. Set up the dumpy and staff, make sure staff sections are locked – pages 6/7.
3. Orient yourself – top of "Survey Log" North – survey starts at North/West corner of green.
4. First reading after setting up and last reading before packing up are to the datum.
5. First reading on the green is taken at a point equidistant (length to first mark on cord) from the two sides at North/West corner.
6. Read staff at every mark on the cord, at end of row the cord is moved 2 meters; using canes and readings are taken in reverse direction. Repeat crisscrossing the green until whole green is surveyed.
7. Make sure that readings are correctly recorded on the "Survey Log". When staff moving West to East record readings left to right on "Survey Log", when staff moving East to West record readings right to left on "Survey Log". Note arrows on "Survey Log"

The survey must be done exactly as outlined; operation of the spreadsheets requires this.

Creating a Bowling Green Profile using a Dumpy Level and Excel

Positioning the Dumpy

Where the dumpy is set up for the survey depends on preference and experience:

- Midpoint side of green;
  - readings are not taken looking into sun.
  - some readings will be over long distance.
- Midpoint of green;
  - readings will be over shorter distance.
  - some readings may be into sun.
  - can't take readings in area of dumpy set up.
  - use average of surrounding blocks for those readings that can't be taken.

Survey Interrupted

It may be that the survey must be interrupted, in this case proceed as follows:

- Mark last reading on "Survey Log"
- Mark row interrupted on ditch boards

When restarting survey, after setting up dumpy proceed as follows:

- Use same "Survey Log" as before
- Enter date above original date, read datum and enter reading above original datum reading.
- Use marks on ditch boards to restart at interrupted row – complete row.
- Complete survey

The dumpy readings now must be adjusted; subtract restart datum reading from original datum reading:

- If positive original setup of dumpy higher – add difference to readings taken after restart to get onto same base.
- If negative original setup of dumpy lower – subtract difference from readings taken after restart to get onto same base.