BOWLING GREEN VERTICAL CONTROL NETWORK (BGVCN)

THE CITY OF BOWLING GREEN

June 2009

ENGINEERS ▪ ARCHITECTS ▪ PLANNERS

POGGEMEYER DESIGN GROUP

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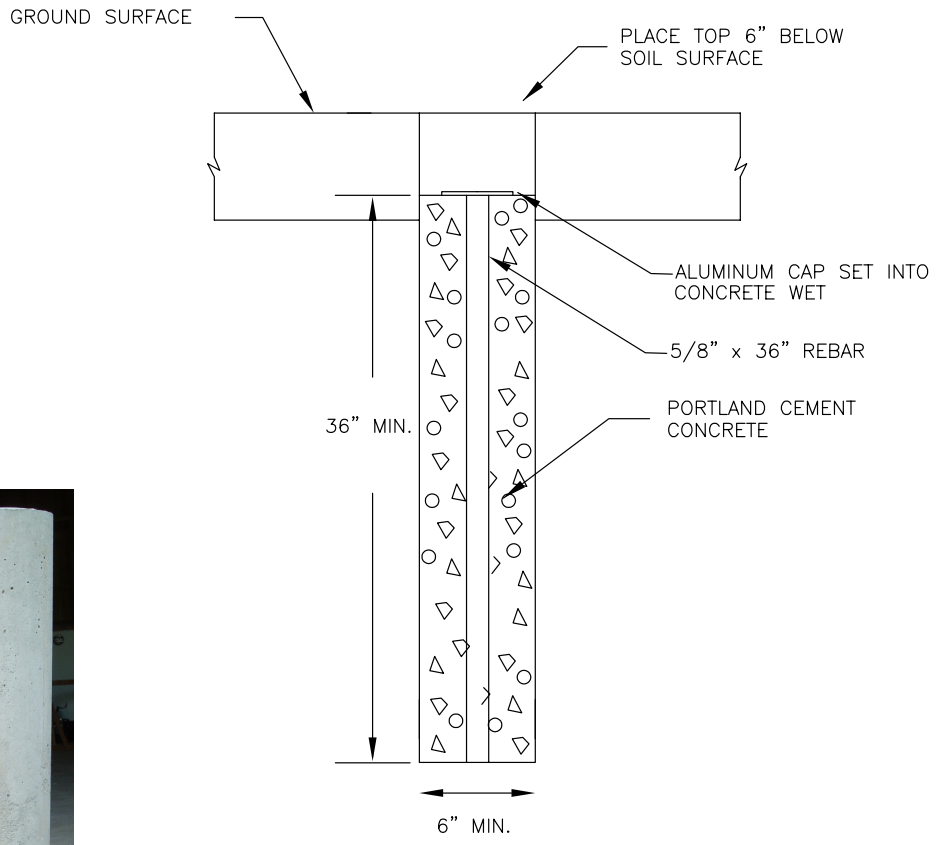
INTRODUCTION

This report by **Poggemeyer Design Group** (PDG) is to summarize professional surveying services prepared for The City of Bowling Green for the Bowling Green Vertical Control Network (BGVCN). PDG has completed all of the fieldwork and calculations required to report elevations on fifteen (15) concrete monuments surrounding Bowling Green, Ohio.

The BGVCN meets the National Geodetic Survey's current Elevation Accuracy Standards for a Second Order–Class II Vertical Control Network. This Vertical Control Network consists of fifteen (15) existing monuments, previously constructed by BG or others, and four (5) existing First Order–Class II monuments, previously maintained by National Geodetic Survey (NGS). There is no anticipation to "Blue Book" any of the fifteen BGVCN monuments to the NGS database. This report will briefly outline the technical approach and calculations performed on this project.



VERTICAL MONUMENT DETAIL

CITY OF BOWLING GREEN PUBLIC WORKS DEPARTMENT ENGINEERING DIVISION	STD DWG SH 1 OF 1 REV 10/2008

TECHNICAL APPROACH

Personnel

- Dana A. Parsell, P.S. – Project Manager
- Michael A. Horn, P.S.
- John C. Bair
- Jordan M. Atherine
- Kevin H. Mielnik

vEquipment

- Trimble DiNi Digital Level (0.3mm per km)
  - Part No: 7 8030 017
  - Manufactured: 2009
  - Serial No. 708274
- Two (2) Staffs – Trimble Invar Rod LD 13 with bipods
  - Each staff is a three (3) meter, code-graduated rod.
- Two (2) Footplates with steel punch
  - Footplates used for turning points at each station.
- One (1) Trimble 5800 dual-frequency GPS receiver with Trimble TSC2 data collector.
  - Motorola i580 cellular phone to connect to Ohio Department of Transportation (ODOT) Virtual Reference System.
  - GPS receiver used for reconnaissance, recovery, and review of existing monumentation.

Level Loop Routes

PDG planned, coordinated, and performed three (3) level loops routes. This route was pre-approved by National

Geodetic Survey prior to performing any fieldwork for this project.

Route No. 1

Lineal Distance 51,204 feet +/-

Closure 0.041 feet

Route No. 2

Lineal Distance 80,006 feet +/-

Closure 0.054 feet

Route No. 3

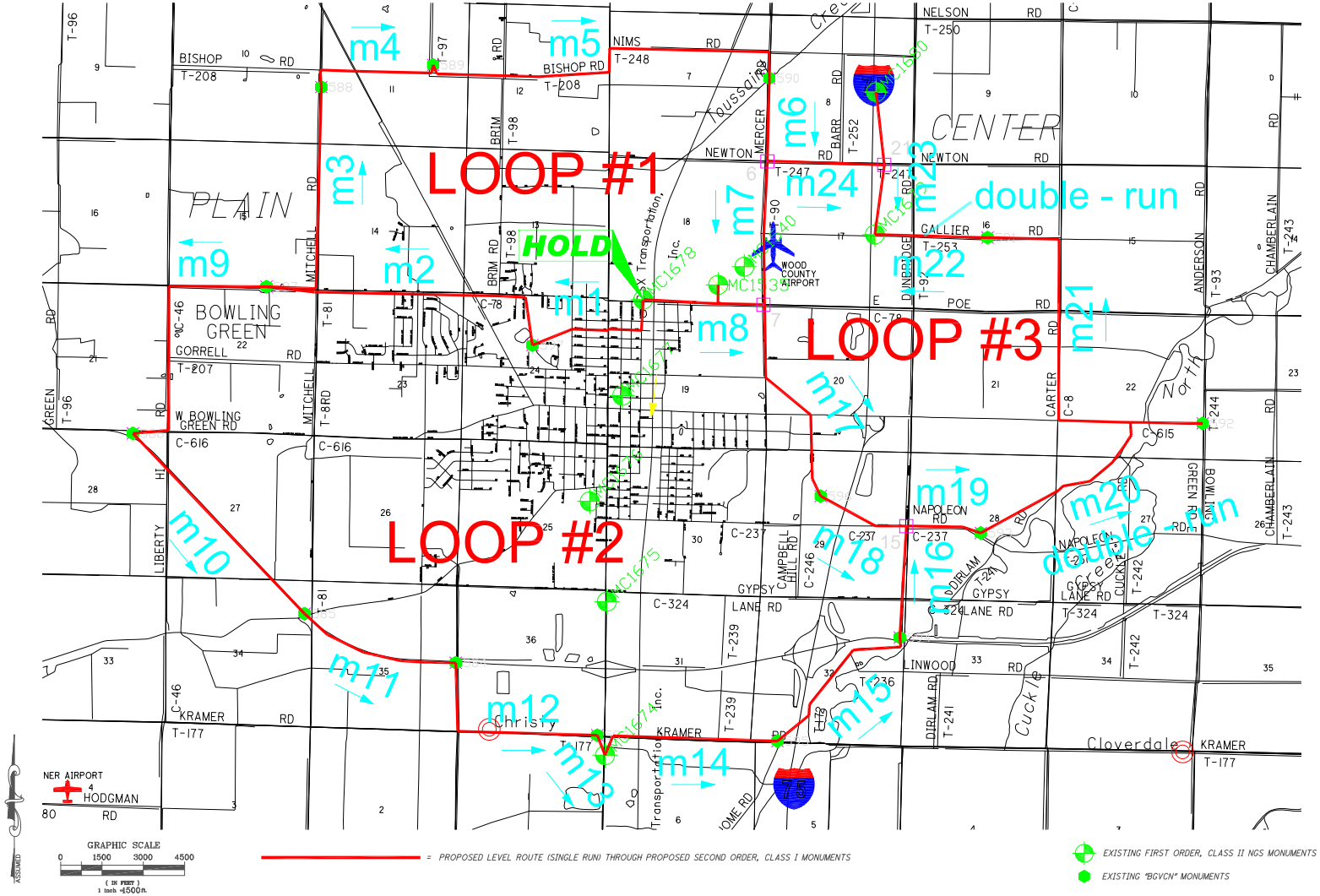
Lineal Distance 51,081 feet +/-

Closure 0.057 feet*

* Note: Part of this route was double-run to check existing measurements, verify measurement ties to existing vertical control, and minimize errors in the overall adjustment.

CALCULATIONS

PDG compiled the survey data and performed a Least Squares Adjustment (LSA) of the survey information.



A Priori Data: As directed by The City of Bowling Green, all survey data is to be referenced to the following existing NGS monument: (See NGS Data Sheet attached)

PID
MC1678

DESIGNATION
C351

NAVD 88
675.00'

MONUMENT
Stainless Steel Rod in Sleeve

CALCULATIONS

Least Squares model

B * X = M + C

B = linear model / matrix

X = unknown values

M = measurements

C = corrections or adjustments

B=

$$B := \begin{pmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \\
0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}$$

Variance / Covariance Matrix and Weight Matrix

We need to assign residual (Φ) and variance (Φ2) values for the precisions of each measurement. Please note, PDG has conservatively estimated the precisions of each measurement for the purpose of providing weight in this adjustment. For this project, we have used the following values:

m1 thru m20 .....residual (Φ) = 0.05' variance (Φ2) = 0.0025'

m21 .....residual (Φ) = 0.20' variance (Φ2) = 0.04'

m22 thru m24.....residual (Φ) = 0.05' variance (Φ2) = 0.0025'

m25 and m26.....residual (Φ) = 0.005' variance (Φ2) = 0.000025'

V = Variance / Covariance matrix

Cov :=

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-3}$	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-5}$	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$2.5\cdot10^{-5}$

Variance / Covariance Matrix and Weight Matrix

V^{-1}= Weight matrix

$Cov = I$

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	400	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	$4 \cdot 10^4$
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CALCULATIONS

Normal Equations

$(BT * V^{-1} * B) * X = BT * V^{-1} * M$

Solving for X:

$X = (BT * V^{-1} * B)^{-1} * (BT * V^{-1} * M)$

$B^T =$

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	-1	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0
6	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-1	-1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	1	0	0

B^T

CALCULATIONS

Normal Equations

M = M measured

m1	=	X1-HA	=	678.022’
m2	=	X2-X1	=	-3.202’
m3	=	X3-X2	=	-1.780’
m4	=	X4-X3	=	0.384’
m5	=	X5-X4	=	-3.138’
m6	=	X6-X5	=	1.693’
m7	=	X7-X6	=	3.193’
m8	=	X7-HA	=	675.131’
m9	=	X8-X2	=	0.158’
m10	=	X9-X8	=	14.355’
m11	=	X10-X9	=	-3.561’
m12	=	X11-X10	=	-2.399’
m13	=	X12-X11	=	-1.464’
m14	=	X13-X12	=	-5.126’
m15	=	X14-X13	=	-7.301’
m16	=	X15-X14	=	4.451’
m17	=	X16-X7	=	-1.255’
m18	=	X15-X16	=	0.003’
m19	=	X17-X15	=	-4.139’
m20	=	X18-X17	=	-2.5385’
m21	=	X19-X18	=	1.500’
m22	=	X20-X19	=	0.140’
m23	=	X20-X21	=	1.272’
m24	=	X21-X6	=	-4.473’
m25	=	X20-HA	=	668.74’
m26	=	X12-HA	=	681.87’

Solving for X:

$$X = (B^T * V^{-1} * B)^{-1} * (B^T * V^{-1} * M)$$

$$x := \left[\left(B^T\right)\cdot Cov\cdot B\right]^{-1}\cdot\left(B^T\cdot Cov\cdot meas\right)$$

x =

	0
0	678.014
1	674.805
2	673.024
3	673.407
4	670.268
5	671.96
6	675.138
7	674.956
8	689.305
9	685.737
10	683.332
11	681.861
12	676.729
13	669.421
14	673.866
15	673.876
16	669.713
17	667.16
18	668.659
19	668.786
20	667.5

X1	=	678.014’	=	Point #597
X2	=	674.805’	=	Point #587
X3	=	673.024’	=	Point #588
X4	=	673.407’	=	Point #589
X5	=	670.268’	=	Point #590
X6	=	671.960’	=	Point TP6
X7	=	675.138’	=	Point TP3
X8	=	674.956’	=	Point #586
X9	=	689.305’	=	Point #585
X10	=	685.737’	=	Point #584
X11	=	683.332’	=	Point #583
X12	=	681.861’	=	Point #MC
X13	=	676.729’	=	Point #595
X14	=	669.421’	=	Point #594
X15	=	673.866’	=	Point TP4
X16	=	673.876’	=	Point #596
X17	=	669.713’	=	Point #593
X18	=	667.160’	=	Point #592
X19	=	668.659’	=	Point #591
X20	=	668.786’	=	Point #MC
X21	=	667.500’	=	Point TP2

CALCULATIONS

Normal Equations

B * x	=	Mc corrected
Mc1	=	678.013’
Mc2	=	-3.211’
Mc3	=	-1.784’
Mc4	=	0.380’
Mc5	=	-3.142’
Mc6	=	1.689’
Mc7	=	3.191’
Mc8	=	675.136’
Mc9	=	0.154’
Mc10	=	14.351’
Mc11	=	-3.565’
Mc12	=	-2.403’
Mc13	=	-1.468’
Mc14	=	-5.130’
Mc15	=	7.305’
Mc16	=	4.447’
Mc17	=	-1.252’
Mc18	=	0.004’
Mc19	=	-4.140’
Mc20	=	-2.540’
Mc21	=	1.398’
Mc22	=	0.139’
Mc23	=	1.270’
Mc24	=	-4.475’
Mc25	=	668.740’
Mc26	=	681.870’

Mc corrected	-	M measured	=	Δ adjustment
678.013’	-	678.022’	=	-0.008561’
-3.211’	-	-3.202’	=	-0.008561’
-1.784’	-	-1.780’	=	-0.004195’
0.380’	-	0.384’	=	-0.004195’
-3.142’	-	-3.138’	=	-0.004195’
1.689’	-	1.693’	=	-0.004195’
3.191’	-	3.193’	=	-0.002238’
675.136’	-	675.131’	=	0.004861’
0.154’	-	0.158’	=	-0.004367’
14.351’	-	14.355’	=	-0.004367’
-3.565’	-	-3.561’	=	-0.004367’
-2.403’	-	2.399’	=	-0.004367’
-1.468’	-	-1.464’	=	-0.004367’
-5.130’	-	-5.126’	=	-0.003646’
7.305’	-	-7.301’	=	-0.003646’
4.447’	-	4.451’	=	-0.003646’
-1.252’	-	-1.255’	=	0.002623’
0.004’	-	0.003’	=	-0.002623’
-4.140’	-	-4.139’	=	-0.001023’
-2.540’	-	-2.5385’	=	-0.001023’
1.398’	-	1.500’	=	0.102000’
0.139’	-	0.140’	=	-0.001023’
1.270’	-	1.272’	=	-0.001956’
-4.475’	-	-4.473’	=	-0.001956’
668.740’	-	668.740’	=	0.000186’
681.870’	-	681.870’	=	0.000045’

SUMMARY

PDG has completed the Bowling Green Vertical Control Network and reports the following measured data:

POINT	NORTHING	EASTING	LATITUDE	LONGITUDE	DESCRIPTION	ELEVATION
583	612536.466	1652374.869	41ø20'32.01937"N	83ø39'04.70574"W	KRAMER & US 25	683.332'
584	615168.363	1647234.98	41ø20'57.34381"N	83ø40'12.54449"W	RT 6 AND RUDOLPH	685.737'
585	616950.271	1641741.745	41ø21'14.21263"N	83ø41'24.87846"W	RT 6 AND SAND RIDGE	689.305'
586	623498.131	1635511.004	41ø22'18.04939"N	83ø42'47.76199"W	RT 6 AND BG ROAD	674.956'
587	628825.422	1640362.947	41ø23'11.33839"N	83ø41'45.09040"W	POE ROAD	674.805'
588	636073.041	1642352.189	41ø24'23.20428"N	83ø41'20.29320"W	MITCHELL ROAD	673.024'
589	636877.531	1646411.42	41ø24'31.69492"N	83ø40'27.17320"W	HULL PRAIRIE	673.407'
590	636399.449	1658620.925	41ø24'28.56526"N	83ø37'46.88130"W	MERCER ROAD/TOUSSAINT	670.268'
591	630607.469	1666547.341	41ø23'32.34853"N	83ø36'01.91435"W	GALLIER	668.659'
592	623861.225	1674361.516	41ø22'26.66439"N	83ø34'18.31560"W	BG ROAD & HOUSEKEEPER	667.160'
593	619881.104	1666302.802	41ø21'46.35328"N	83ø36'03.34599"W	NAPOLEON	669.713'
594	616084.192	1663362.007	41ø21'08.47527"N	83ø36'41.27311"W	RT 6 AND DUNBRIDGE	669.421'
595	612323.685	1658918.561	41ø20'30.76190"N	83ø37'38.89163"W	KRAMER & COUNTY HOME	676.729'
596	621219.086	1660486.709	41ø21'58.83878"N	83ø37'19.83606"W	CARTER PARK	673.876'
597	626701.595	1650019.34	41ø22'51.64637"N	83ø39'38.05409"W	CITY PARK	678.014'
MC1535	628889.785	1656760.908	41ø23'14.14005"N	83ø38'10.00402"W	NGS MONUMENT	671.358'
MC1674	611856.349	1652697.962	41ø20'25.34266"N	83ø39'00.35291"W	NGS MONUMENT	681.861'
MC1678	628356.074	1654038.595	41ø23'08.51574"N	83ø38'45.62186"W	NGS MONUMENT (HELD)	675.000'
MC1679	630720.225	1662453.226	41ø23'32.94857"N	83ø36'55.64204"W	NGS MONUMENT	668.786'
MC1680	635875.57	1662588.183	41ø24'23.89439"N	83ø36'54.73643"W	NGS MONUMENT	667.288'

Coordinate System
United States State Plane 1983
(ground coordinates)

Zone
Ohio North (Zone 3401)

Datum Transformation
NAD 83

Ground Scale factor
1.0000749645

APPENDIX 1: DATA SHEETS

APPENDIX 2: RAW DATA