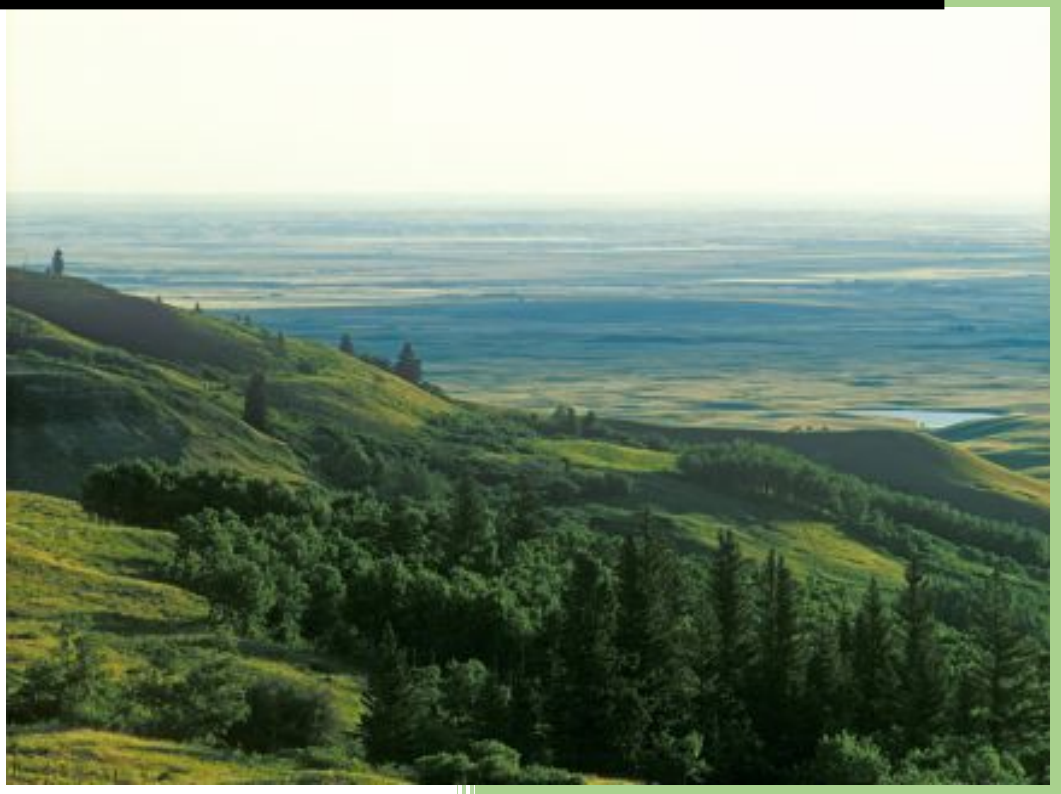
Wild Raspberry RV Park Survey



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Feb. 20, 2017

Wild Raspberry RV Park Survey

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Feb. 20, 2017

Executive Summary

This report details how the Maple Creek, Midwest Surveys office (Midwest) surveyed the Wild Raspberry RV Park. It briefly describes the topographic survey undertaken to assist in the campground's design. However, it focuses on the establishment of control points and the layout of the campground's design. The surveys described in this report were completed between November 2014 and April 2016.

The Wild Raspberry RV Park is located in Cypress Hills Interprovincial Park, Saskatchewan. Cypress Hills Interprovincial Park is one of southwest Saskatchewan's most popular tourist destinations, located approximately 20 minutes south of Maple Creek, Saskatchewan.

The survey was completed for a client who required it to receive construction approval from Saskatchewan Parks to build the campground. To aid in the design of the RV Park, Midwest was hired to carry out a topographic survey of the project area. The client also hired Midwest to lay out the individual lots and the boundaries of the campground. The client did not specify any external standards or accuracies for the surveys. The instruments used to complete the survey tasks included Real Time Kinematic GPS, Total Stations and Pipe Locators.

Because the area did not have existing control monuments, Midwest had to establish their own. To do so, they set up a static GPS network. The placed control monuments then served as station locations and check shots throughout the project and allowed Midway to stake out the preliminary campground design. This initial design required some adjustments to compensate for rough terrain, requiring the redesign of several lots and a portion of the road, which Midway did in-house.

In April 2016, Saskatchewan Parks approved construction of the campground. At that point, the client hired Midwest to position the RV Park's sewer system, for which Midway used real time kinematic GPS and Total Stations.

In total, Midwest performed five surveys at the Wild Raspberry RV Park. They provided the client with topographic plans and sketch plans, which ultimately lead to approval of the campsite's construction. Layout of the campground's sewer system concluded Midwest's involvement with the project.

Acknowledgements

The authors would like to thank the following people for providing information and helping with the creation of this report:

- Christopher Thornton, Instructor, BCIT, for providing guidance throughout the duration of the report.
- Nathan Devos, Instructor, BCIT, for offering insight in both the language and formatting realms.
- Dallas Lazar, S.L.S, Midwest Surveys, for providing documentation and explanations about the work performed.
- Gary Churchill, Partner, D & G Golf Enterprise Ltd., for allowing the authors to pursue the RV Park as the topic of this report.

Table of Contents

Executive Summary iii
Acknowledgements iv
Table of Contents v
List of Figures vi
List of Tables vi
1.0 Introduction 1
1.1. Background 1
1.2. Purpose 2
1.3. Scope of Report 2
1.4. Authorization 2
1.5. Methodology 2
1.6. Overview 2
2.0 Specifications 3
2.1. Standards 3
2.2. Levels of Accuracy 3
2.3. Instrumentation 3
2.3.1. Global Positioning Systems (GPS) 3
2.3.2. Total Station 4
2.3.3. Pipe Locators 4
2.4. Quality Control 5
3.0 Survey Procedures 6
3.1. Topographic Survey 6
3.2. Control Point Establishment 6
3.3. GPS Data Reduction 6
3.3.1. Static Observation Reduction 6
3.3.2. Real Time Kinematic Observation Reduction 7
3.4. Initial Design Layout 7
3.5. Complications and Redesign 7
3.6. Location of Existing Utilities 8
3.7. Sewer Layout 8
4.0 Client Deliverables 10
4.1. Survey Plan 10
4.2. Approval 10
5.0 Conclusions 11

6.0 References 12
Appendix A: Topographic Survey Field Sketches
Appendix B: Approximate Location of Control Points
Appendix C: Design Plans Provided by David Powell, Landscape Architect
Appendix D: Location of Power Line and Redesign Sketch
Appendix E: Sewer Design Plans Provided by WSP
Appendix F: Location of Sewer Offsets and Sewer Benchmarks
Appendix G: Revised Sketch Plan

List of Figures

Figure 1: Location of Cypress Hills Interprovincial Park 1
Figure 2: Trimble R10 Receiver 3
Figure 3: Topcon ES-103 Total Station 4
Figure 4: SPX RD8000 4
Figure 5: Check Shots in Field Notes 5
Figure 6: Typical Lot Dimensions 7
Figure 7: Sketch of Road Diversion 8
Figure 9: Offset Trig Leveling Notes 9
Figure 8: Benchmark Trig Leveling Notes 10

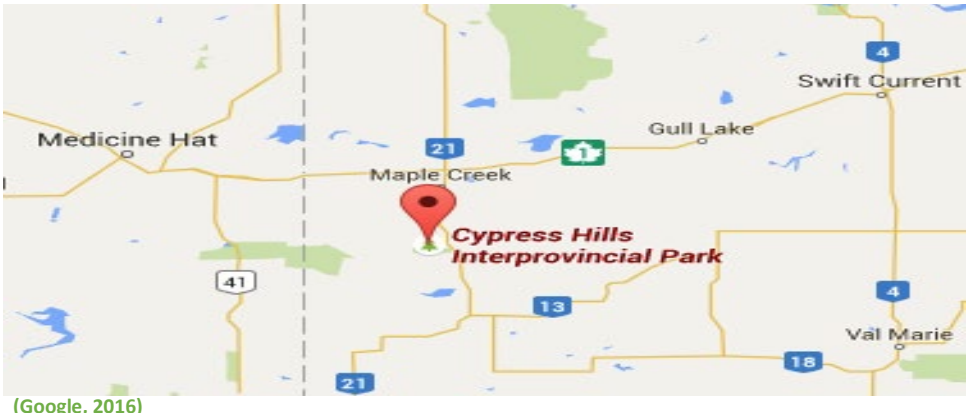
List of Tables

Table 1: Trimble R10 Positioning Performance 4

1.0 Introduction

1.1. Background

The Wild Raspberry RV Park is located in Cypress Hills Interprovincial Park, Saskatchewan. Cypress Hills is Canada's first interprovincial park and contains a dark sky preserve[1] that spans the Saskatchewan-Alberta border (Cypress Hills, 2016). Figure 1 shows the approximate location of the park.



(Google, 2016)

Figure 1: Location of Cypress Hills Interprovincial Park

In 2009, Cypress Hills welcomed 279,242 visitors between April and September, a 22.6% spike in visits from 2004 (Saskatchewan Parks, 2009). The Wild Raspberry RV Park is one of many responses to this steep rise in visits.

The surveys were conducted for a client who wanted to construct a campground (called the Wild Raspberry RV Park) within the park boundaries. He required approval of his construction plans from Saskatchewan Parks, which required a survey plan of the intended campground design proving a design that minimized loss to the surrounding forest.

The client hired the Maple Creek Midwest Surveys (Midwest) office to

- carry out a topographic survey of the project area
- lay out the campground and its 53 lots
- locate the position of existing underground utilities
- create a scaled plan of the campground as laid out
- identify the position the campground's sewer system.

Midwest chose to participate in the project because of the park's proximity to Midwest's Maple Creek office and because it offered a change in pace and scenery for a company that predominantly focuses on oil and gas surveys.

[1] A dark-sky preserve (DSP) is an area, usually surrounding a park or observatory, that is kept free of artificial light pollution. The purpose of a dark sky preserve is generally to promote astronomy.

1.2. Purpose

This report focuses on the establishment of control points and the design layout for the construction of the Wild Raspberry RV Park, but also briefly introduces the topographic survey completed to assist in the design of the RV Park.

The fundamental purpose of this report is to identify the standards, instruments and procedures that Midwest used to complete these tasks.

1.3. Scope of Report

This report provides an in-depth look at

- the standards and levels of accuracy required by the surveys
- the instrumentation used and their specifications
- the procedures that were carried out during each survey
- the deliverables produced using the surveys.

This report does not describe activities involving the engineering design process or the construction of the campground.

1.4. Authorization

This report is a course requirement for Communication 2452 and Technical Reports 4470. The course instructors, Nathan Devos and Christopher Thornton, respectively, authorized the report topic.

1.5. Methodology

Dallas Lazar, a Saskatchewan Land Surveyor at Midwest, provided the documentation to complement the information in this report. Material was also gathered from various internet sources to help explain details of the report.

1.6. Overview

Section 2 outlines the instruments and standards employed during the surveys, Section 3 details the survey procedures employed by Midwest's crews, Section 4 highlights the deliverables produced by the surveys, Section 5 provides the report's conclusion, and, lastly, Section 6 lists the report's references.

2.0 Specifications

Section 2 describes the standards and levels of accuracy mandated for the surveys performed by Midwest, as well as the instrumentation used by the survey crews and their levels of accuracy. The last part of this section outlines how the surveyors ensured consistent quality throughout the project.

2.1. Standards

The survey tasks performed for this job were not bound by any external or client standards. The survey crews followed "Standards of Practice" as outlined in the Saskatchewan Land Surveyor Association (SLSA) By-laws.

2.2. Levels of Accuracy

Neither Saskatchewan Parks nor the client requested a specific closure for the measurements. Since no measurement accuracies were specified, the crews followed Section 4, Article XIII in the SLSA By-Laws, which states:

> "It shall be good practice to obtain a minimum closure in raw field data of one part in five thousand." (Saskatchewan Land Surveyor Association, 2011)

Therefore, the relative precision of 1:5000 was the minimum objective for the surveyors and pertains to both horizontal and vertical positioning.

2.3. Instrumentation

Since the project area was heavily forested, the crews used three types of equipment to perform the surveys: global positioning systems (GPS), total stations, and pipe locators. The following subsections describe these types of instrumentation in more detail.

2.3.1. Global Positioning Systems (GPS)

GPS was the preferred instrumentation for most this project. GPS offered the crews more than enough precision while delivering the highest efficiency. Two types of GPS were used during the survey: real time kinematic (RTK) and static. The specific GPS unit that Midwest used was the Trimble R10. Figure 2 depicts the Trimble R10 receiver.

The positioning performance of the Trimble R10 system is outlined in Table 1, which contains the expected performance for both RTK and static observations. The values shown under "Static and Fast Static" as well as "Single Baseline <30 km" applied to this project.

Source: Trimble R10 GNSS System, 2016

Figure 2: Trimble R10 Receiver

Table 1: Trimble R10 Positioning Performance

POSITIONING PERFORMANCE[1]	
Code differential GNSS positioning	
Horizontal	0.25 m + 1 ppm RMS
Vertical	0.50 m + 1 ppm RMS
SBAS differential positioning accuracy[2]	typically <5 m 3DRMS
Static GNSS surveying	
High-Precision Static	
Horizontal	3 mm + 0.1 ppm RMS
Vertical	3.5 mm + 0.4 ppm RMS
Static and Fast Static	
Horizontal	3 mm + 0.5 ppm RMS
Vertical	5 mm + 0.5 ppm RMS
Real Time Kinematic surveying	
Single Baseline <30 km	
Horizontal	8 mm + 1 ppm RMS
Vertical	15 mm + 1 ppm RMS
Network RTK[3]	
Horizontal	8 mm + 0.5 ppm RMS
Vertical	15 mm + 0.5 ppm RMS
RTK start-up time for specified precisions[4]	2 to 8 seconds
Trimble CenterPoint RTX	
Horizontal	4 cm
Vertical	9 cm
RTX convergence time for specified precisions[12]	30 minutes or less
RTX QuickStart convergence time for specified precisions[12]	5 minutes or less
Trimble xFill[5]	
Horizontal	RTK[6] + 10 mm/minute RMS
Vertical	RTK[6] + 20 mm/minute RMS

Source: Trimble R10 GNSS System, 2016

2.3.2. Total Station

During the surveys, GPS was not available where the tree canopy blocked the satellite signal. In these locations, Midway used traditional survey equipment: Total Station. Specifically, Midway relied on the Topcon ES-103 (see Figure 3). The ES-103 has a minimum resolution of one arc second and an accuracy of three arc seconds. For distance measurements this Total Station can operate in prism or non-prism modes. The prism accuracy is 2 mm + 2 ppm and the non-prism accuracy is 3 mm + 2 ppm (ES series | Topcon Positioning Systems, Inc., 2016).

2.3.3. Pipe Locators

To locate existing underground utilities, the crews used radiographic pipe locators, specifically the SPX RD8000 (See Figure 4).

Source: ES s

Figu

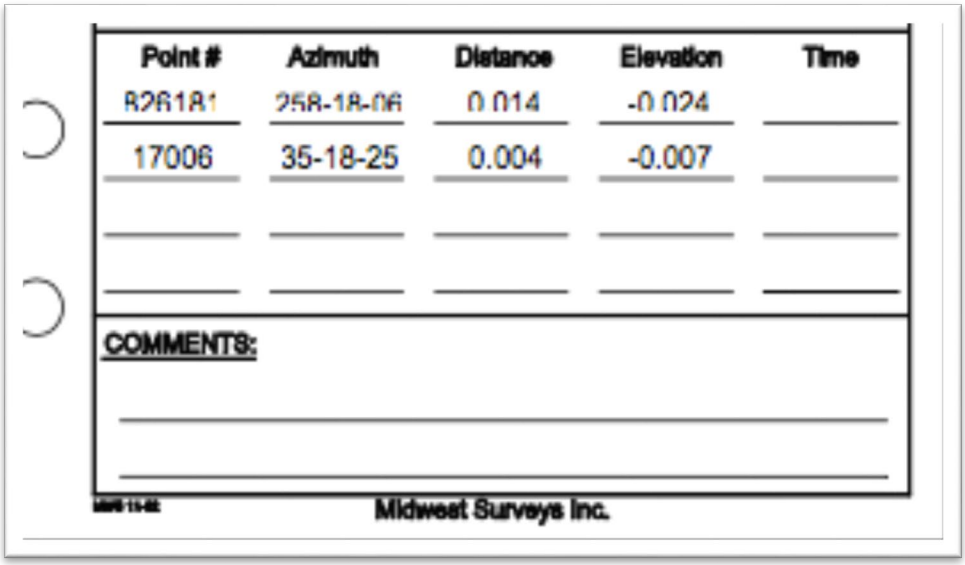
Source: SPX Corporation, 2016

Figure 4: SPX RD8000

For line locating purposes, the RD8000 has a maximum depth of 6 m and a depth accuracy of ± 5%, up to 3 m. In terms of horizontal accuracy, the locator is accurate within ± 5% of the total depth (SPX Corporation, 2016).

2.4. Quality Control

To ensure that quality was preserved throughout the project, Midway took check shots at the start of every day. To take a check shot, the crews set up the RTK base over a known point. Once the base was set up, the rover was taken to another known point. From this point, an observation was taken and the values were recorded. Comparing the values from the observed coordinates and the known coordinates allowed the surveyors to assess their projected quality. The check shot values were recorded on the title page of that day's field notes. Figure 5 shows a sample title page indicating the point collected, the azimuth, the delta distance and the delta elevation of the observed point compared to the known point.



Point #	Azimuth	Distance	Elevation	Time
R261A1	258-18-06	0.014	-0.024	
17006	35-18-25	0.004	-0.007	

COMMENTS:

Midwest Surveys Inc.

Source: T. D. J. Lazar (Personal Communication, April 7, 2016)

Figure 5: Check Shots in Field Notes

3.0 Survey Procedures

To gain Saskatchewan Parks' approval for the client, Midwest performed four separate surveys and tasks:

1. **A topographic survey** that defined the topology and features of the project area to allow the landscape architect to create a design for the RV Park.
2. **Control point establishment**: since no control points were available in the project area, crews needed to establish control points through static GPS observations.
3. **GPS data reduction** to ensure the accuracy of the survey
4. **Initial design layout**: the layout of the design points provided by the landscape architect.
5. **Redesign layout** due to on-the-ground complications: particularly rough terrain forced a partial redesign of the campground layout.
6. **Locating existing utilities** to prevent damage to them during construction.
7. **Sewer layout**

The following subsections describe these seven tasks in more detail.

3.1. Topographic Survey

Midway began the topographic survey on November 9, 2014. The objective of this survey was to tie in adjacent roadways, pump houses, sewage sumps and the centreline of the proposed road (See Appendix A), using RTK GPS. The crews also collected elevation data up to 20 m on either side of the proposed road. This survey was completed on November 21, 2014.

The ultimate product of this survey was a contour and feature plan, which was passed on to David Powell Landscape Architecture to aid in their design of the campground.

3.2. Control Point Establishment

No control points were available in the project area. Therefore, Midway needed to set up monuments to provide the necessary quality checks. To set up these monuments, Midway first set up a static GPS network to establish control points.

On July 14, 2015, Midway set up three static stations (#826182, #826183, #826192) in the intermediate project area. Two RTK base stations (#826191, #826181) had already been set up. In total, Midway placed three controls points. Appendix B illustrates the position of these control points. The coordinates obtained for those points served as check shots and instrument stations for subsequent surveys.

3.3. GPS Data Reduction

Accurately reducing the position of the observed control points required a specific procedure. The quality and accuracy of the whole survey depended on the proper reduction of the static observations as well as the RTK observations. The following sub-sections describe how static measurements and RTK measurements are reduced. The RTK reduction process was applied to all the values obtained through RTK measurements.

3.3.1. Static Observation Reduction

Midway performed two reductions for the static GPS observations. Firstly, they converted the corresponding Trimble raw data files (.T02) into receiver independent exchange format files

(RINEX). The converted RINEX files were then submitted to the Canadian Spatial Reference System (CSRS). The CSRS ran the data through their Precise Point Positioning program (PPP). The PPP outputted coordinates, which were used for comparison purposes later.

Secondly, the .T02 files were imported into a Trimble Business Center (TBC) project. Afterwards, Precise orbits/Ephemerides files (.SP3) were downloaded from the CSRS website and imported into the same TBC project. The .SP3 file was then used to correct the observed GPS data for errors caused by misalignment of the observed satellite orbits. Within the TBC project, all of the baselines were then processed to obtain adjusted coordinates for the control points.

Then Midway compared the given CSRS PPP coordinates to the calculated TBC coordinates, eliminating any outlying points. For this survey, no points or baselines were removed.

3.3.2. Real Time Kinematic Observation Reduction

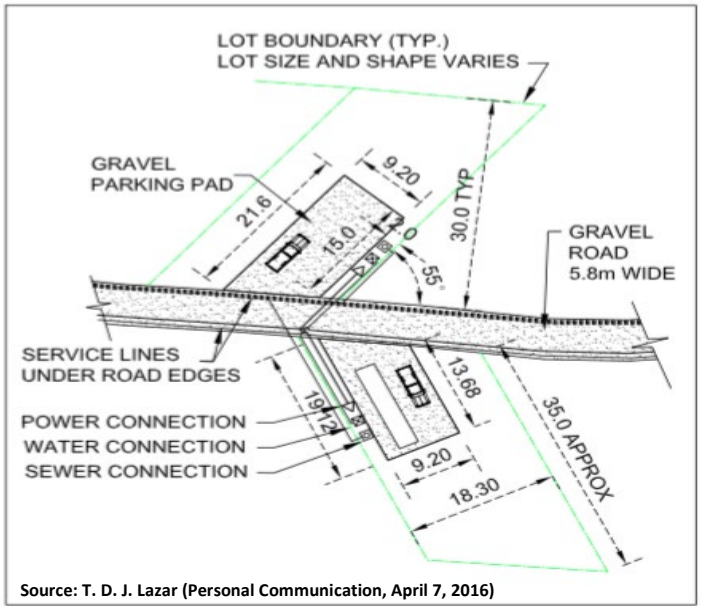
The data collected through RTK observations was transferred into a TBC project through a .job file. Within TBC the collected points and line work was processed and exported into a drawing (.dwg) file. The .dwg file was then passed onto the AutoCAD operators for drafting purposes.

3.4. Initial Design Layout

Crews staked portions of the campground before establishing the control points. However, they left most of the staking until after they had put the control monuments in place. The initial design of the campground was provided to Midwest by David Powell Landscape Architecture (see Appendix C).

Between June 8 and 10, 2015, the crews staked a 1 m offset on either side of the proposed road. On June 28, 2015, they staked the centreline of the proposed road. They used a combination of RTK and total station measurements for both tasks.

Once the control points were established, the crews were able to stake out the designed campground lots. Layout of the overall campground boundary and 17 of the individual lots was completed on July 14, 2015. Figure 6 illustrates the dimensions of the typical individual site that were initially laid out.



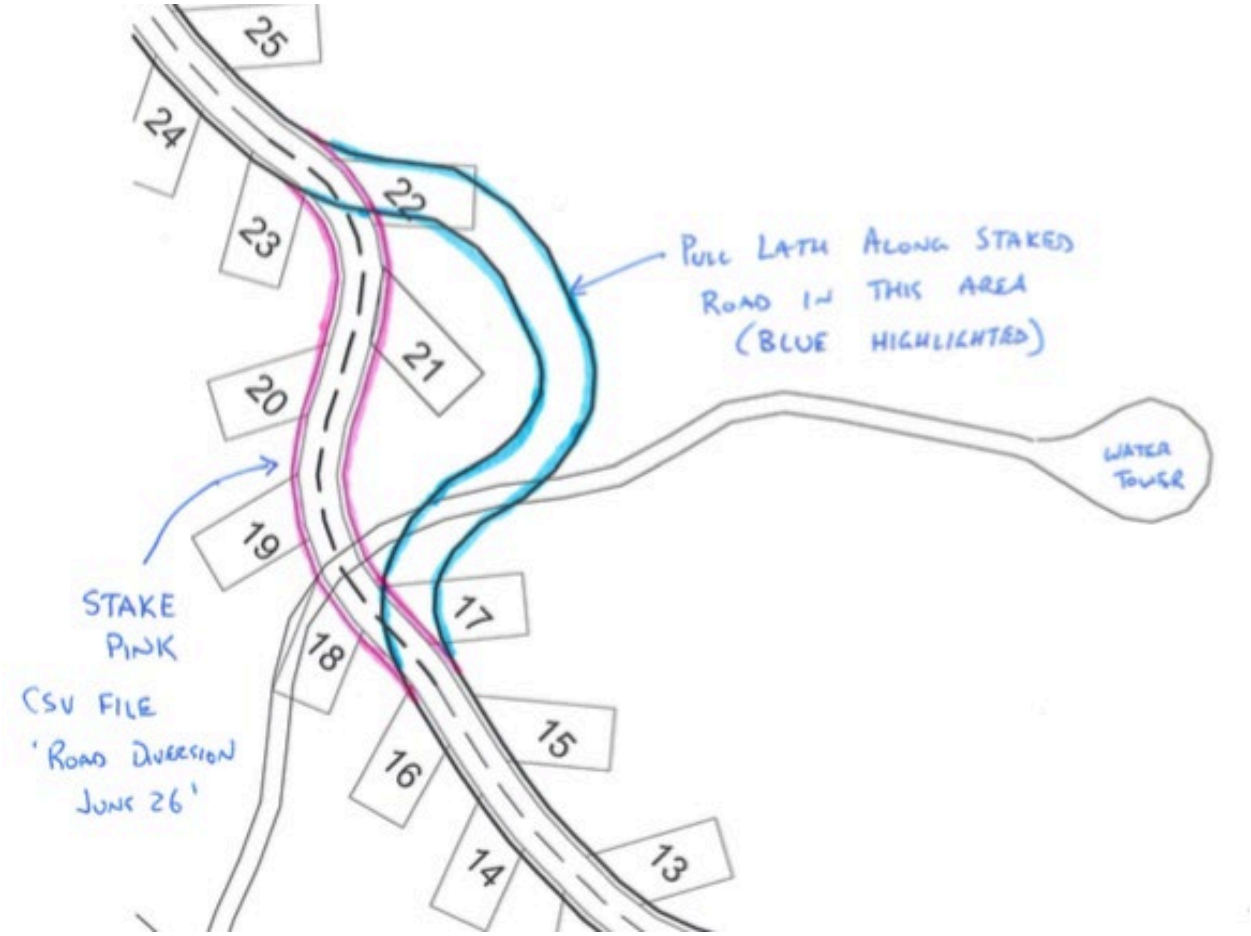
Source: T. D. J. Lazar (Personal Communication, April 7, 2016)

Figure 6: Typical Lot Dimensions

3.5. Complications and Redesign

During a walk about of the site on July 18, 2015, the client noticed that portions of the layout were significantly compromised by the condition of the terrain. As a result, several lots were modified: 3, 4, 19, 21, 25, 27, 29, 30, 32 and 33 (as illustrated in Appendix D.

A large portion of the road was also remodeled because of the rough terrain. Figure 7 depicts the adjusted portion of the road. Midwest's staff handled the redesign of the lots and the road. The reconstructed points were laid out with RTK between July 29 and August 7, 2015.



Source: T. D. J. Lazar (Personal Communication, April 7, 2016)

Figure 7: Sketch of Road Diversion

3.6. Location of Existing Utilities

After staking out the redesigned lots, Midwest crews needed to locate a power line that crossed directly under the project area. Crews located the pipe by using the SPX RD8000 (see Section 2.3.3). Connecting the RD8000 to an exposed portion of the power line enabled crews to track the line's signal across the project area. As crews tracked the signal, they staked the approximate location of the service line to prevent strikes during construction of the campground. Appendix D illustrates the approximate location of the service line.

3.7. Sewer Layout

The final task that Midwest carried out for this job was to lay out the campground's sewer system according to plans provided by WSP Engineering Consultants (WSP) (see Appendix E).

On April 13, 2016, the surveyors laid out the sewer's access holes and access hole offsets using RTK. Appendix F shows the proposed locations of these features.

The surveyors also positioned benchmark points, which they used to run two separate trig leveling loops. The purpose of the first loop was to ascertain elevations relative to the rim elevation provided by WSP for the benchmarks that were previously set out. The purpose of the second loop was to determine the elevations of the proposed access hole offsets. The trig leveling loops were carried out with the Topcon ES-103 Total Station (see Section 2.2.1 for details). The layout of the proposed sewer was finished on April 13, 2016.

Both loops closed with an error less than 1 mm, as shown in Figures 8 and 9. This concluded Midwest's involvement with the project.

TRIG LEVELING

PARTY CHIEF

NEW BM#	(-) B.S.	(+) F.S.	(+) I.F.S.	H.I.	ELEV.	OLD BM#	DESCRIPTION
MH7 12M O\S			0.441				
			0.436				
			0.438		1266.932		
BM 4		2.217					
		2.231					
		2.224			1269.718		ERROR IN LOOP 0.001m

Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Figure 8: Offset Trig Leveling Notes

TRIG LEVELING

PARTY CHIEF

NEW BM#	(-) B.S.	(+) F.S.	(+) I.F.S.	H.I.	ELEV.	OLD BM#	DESCRIPTION
BM 6	-0.837	0.938					
	-0.828	0.947					
	-0.833	0.943		1268.395	1267.562		
BM 5	0.072	0.379					
	0.088	0.387					
	0.080	0.383		1268.698	1268.778		
BM 4	2.354	0.014					
	2.369	0.028					
	2.361	0.021		1266.358	1268.719		
BM 3	-0.495	2.171					
	-0.486	2.184					
	-0.491	2.178		1269.027	1268.536		
BM 2	-0.703	0.272					
	-0.694	0.280					
	-0.698	0.276		1270.001	1269.303		
BM 1	2.638	-0.267					
	2.669	-0.257					
	2.654	-0.262		1267.085	1269.739		
TOP RIM		-2.757					
		-2.733			1264.340		CLOSURE ON LOOP (0.000m)

Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Figure 9: Benchmark Trig Leveling Notes

4.0 Client Deliverables

During the course of the Wild Raspberry RV Park survey, Midwest created several intermediate products. However, the ultimate product was a sketch plan that allowed the landscape architect to design much more comprehensive construction drawings.

4.1. Survey Plan

The final product of this survey was a revised sketch plan that included modifications to compensate for the rough terrain. The revised sketch plan simply illustrated the lot positions with respect to one another. David Powell Landscape Architecture used the sketch plan to alter revise their construction plans. A copy of the revised plan is provided in Appendix G.

4.2. Approval

After the architect made alterations to accommodate the revised campground layout, he passed on the revised survey plan along with his revised construction plans to Saskatchewan Parks. In March 2016, Saskatchewan Parks approved the plans and the client was allowed to begin construction.

5.0 Conclusions

The content of this report outlines the standards, instruments and procedures that the Maple Creek, Midwest Surveys office (Midway) used to survey the Wild Raspberry RV Park. Midwest crews performed five separate surveys over the course of this project and performed the following seven tasks overall:

- A topographic survey of the proposed project area
- Establishment of control points through static GPS observations
- Reduced the GPS data
- Laid out the campground's initial design
- Redesigned the campground's lots and road
- Laid out the redesigned RV Park
- Laid out the campsite's sewer system.

Accomplishing the first five tasks helped the client gain approval from Saskatchewan Parks to construct the campground.

It is our hope that the report demonstrates the methods and techniques applied to complete a survey project of this nature and that the reader has gained an understanding of

- the purpose of the surveys
- where the surveys took place
- the standards and levels of accuracy required by the surveys
- the instruments used during the surveys
- the processes carried out during the surveys
- the products delivered to the client as a result of the surveys.

In closing, the Wild Raspberry RV Park provided Midwest with a unique project. The job required several types of instrumentation and survey practices to produce a final plan. Midwest was capable of adapting to problems as they arose during the project and ultimately delivered a product to their client that satisfied all requirements.

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Appendices

Appendix A: Topographic Survey Field Sketches

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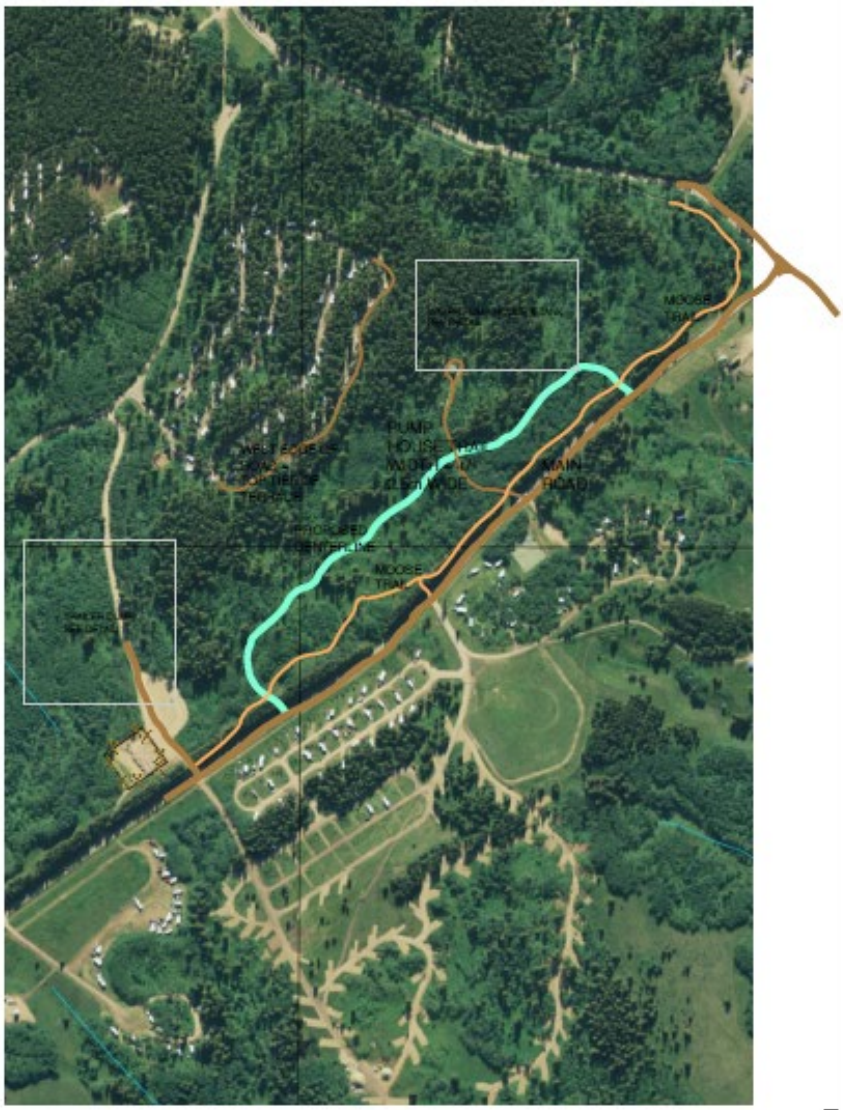
FIELD NOTE DIAGRAM

Page 1 of 1

Crew Chief: T. NELSON
Client: GARRY CHURCHILL
Assistant(s): M. FORAIE / T. DREVER
GPS File Reference: 8-26NOV08TN, 8-26NOV09TN, & 8-26NOV
Date: NOV 8 - 21, 2014
Midwest Job No.: K-1036-14

MIDWEST SURVEYS
www.midwestsurveys.com

LSD: ____ Section: 19 Township: 8 Range: 26 W. 3 Mer.



Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

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FIELD NOTE DIAGRAM

Page 1 of 1

Crew Chief: T. NELSON
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Date: NOV 8 - 21, 2014

Client: GARRY CHURCHILL
GPS File Reference: 8-26NOV08TN, 8-26NOV09TN, & 8-26NOV
Midwest Job No.: K-1036-14

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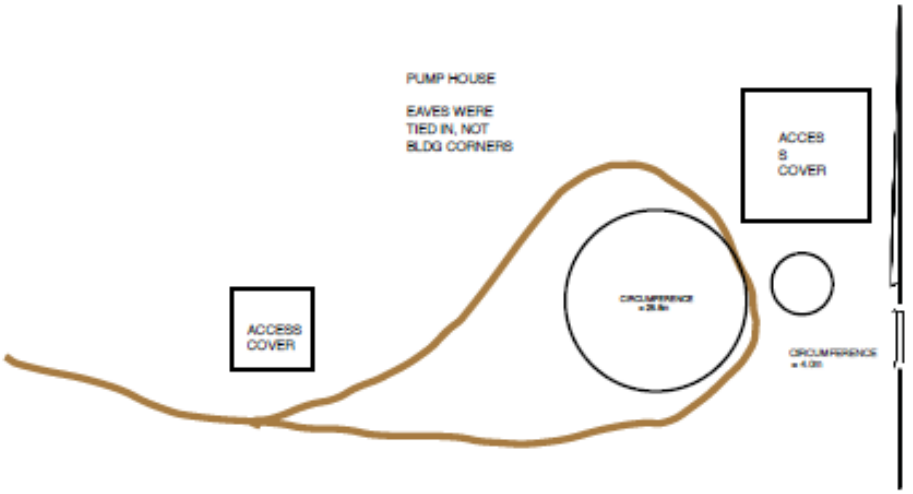
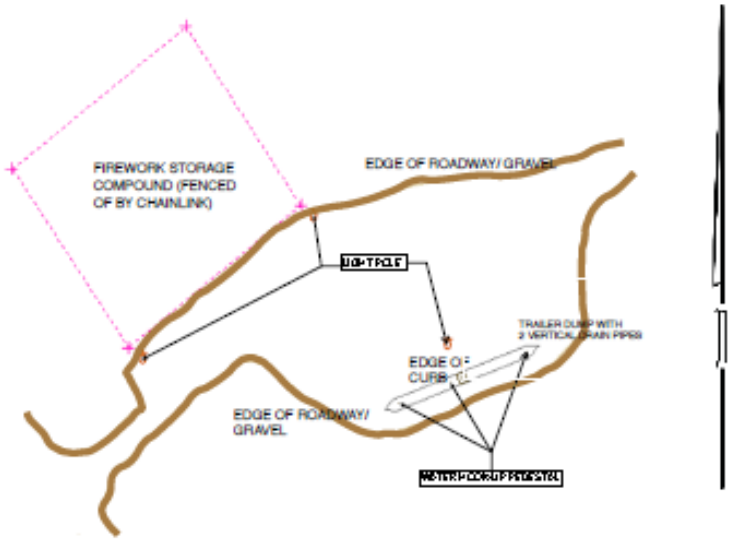
LSD: ____ **Section:** 19 **Township:** 8 **Range:** 26 **W.** 3 **Mer.**

PUMP HOUSE DETAIL

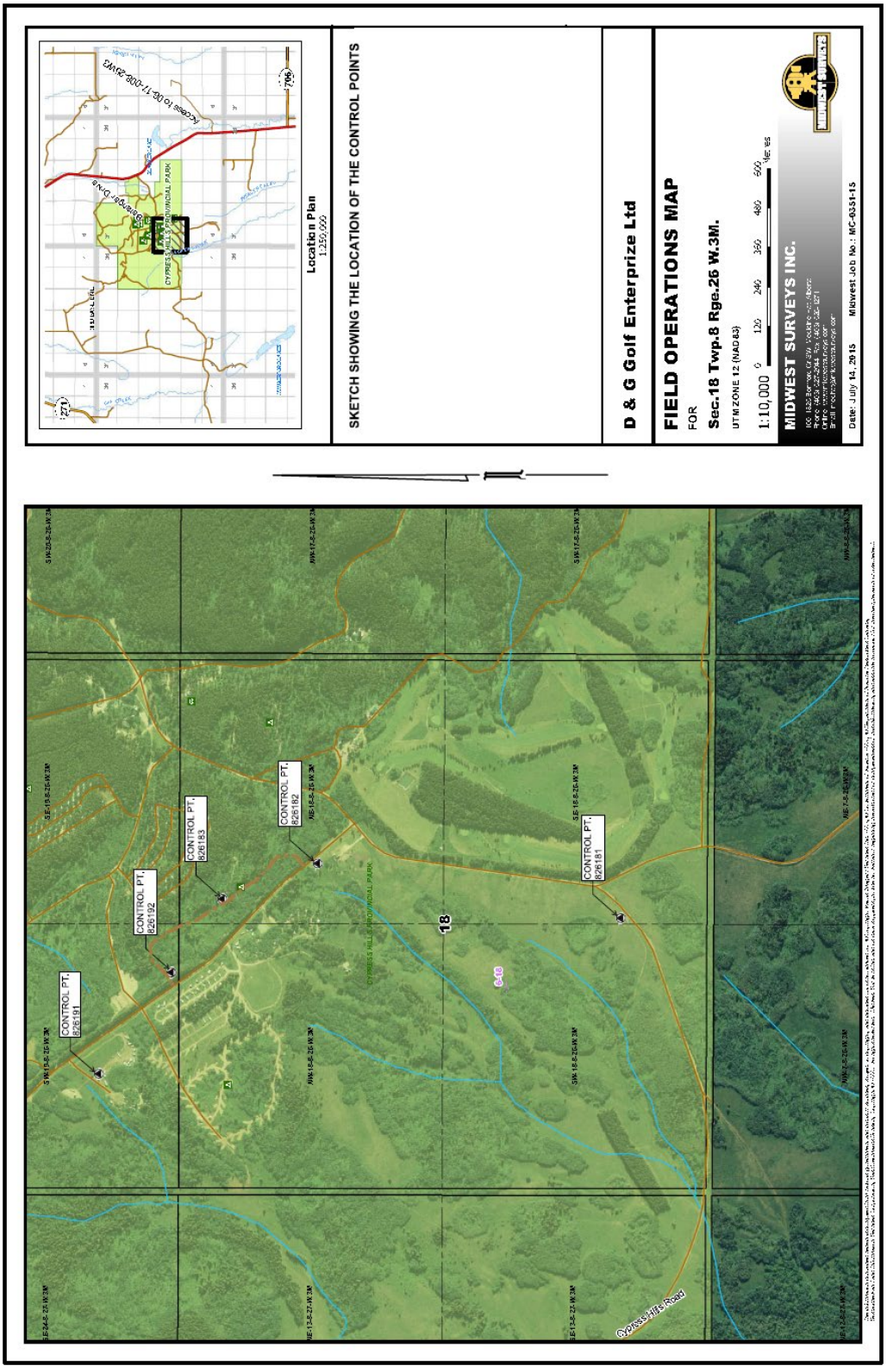


TRAILER DUMP DETAIL



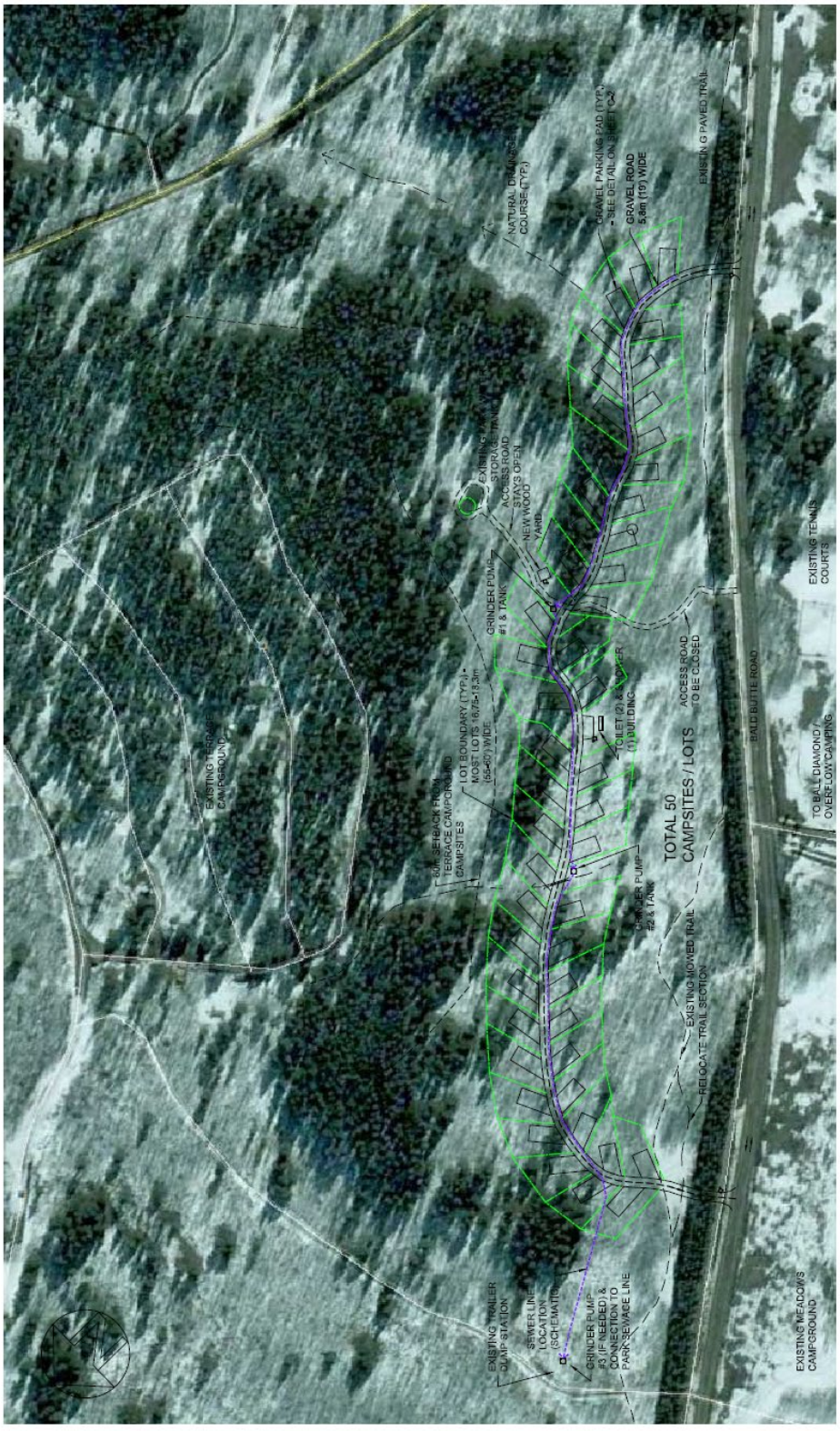
Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Appendix B: Approximate Location of Control Points



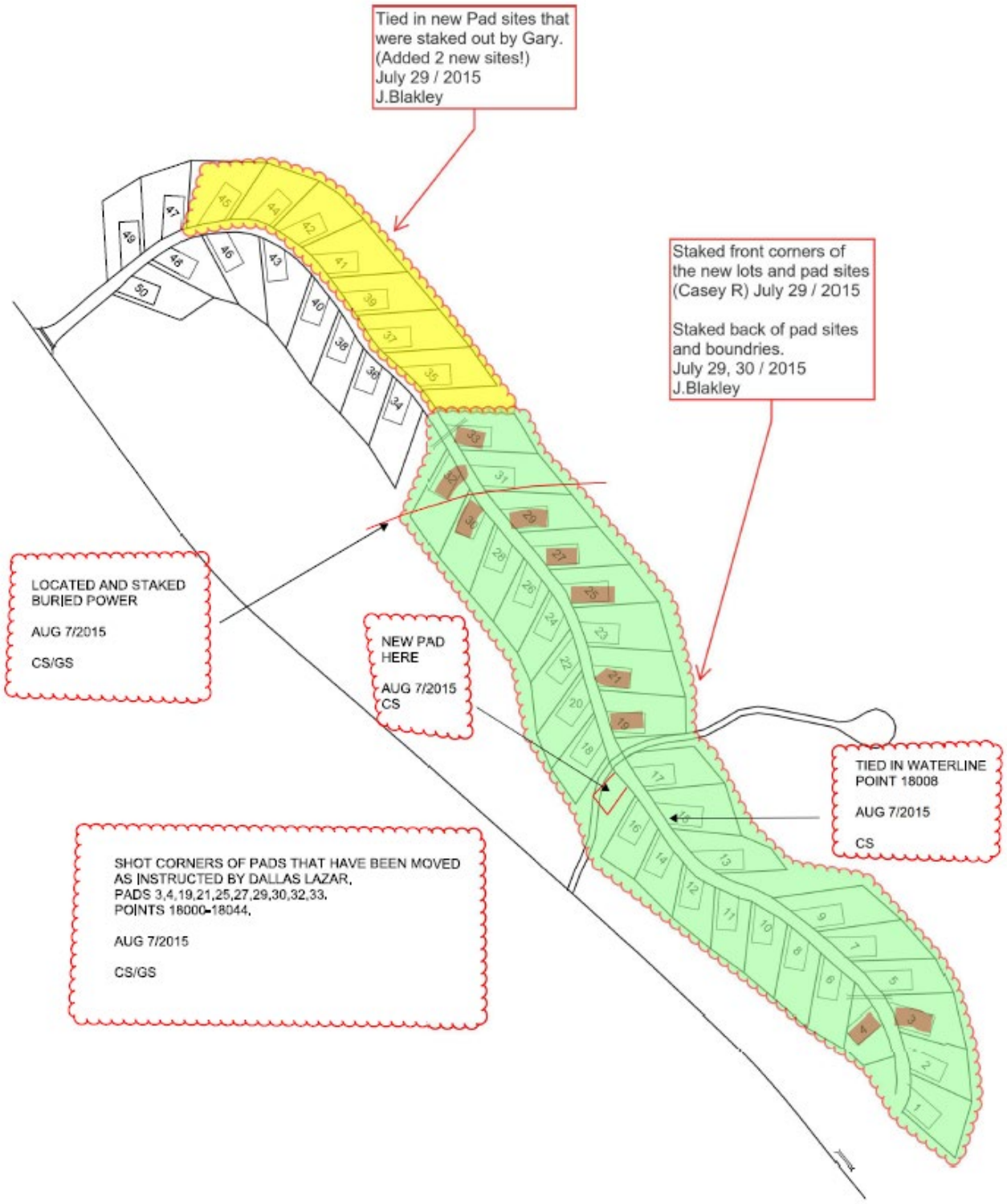
Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Appendix C: Design Plans Provided by David Powell, Landscape Architect



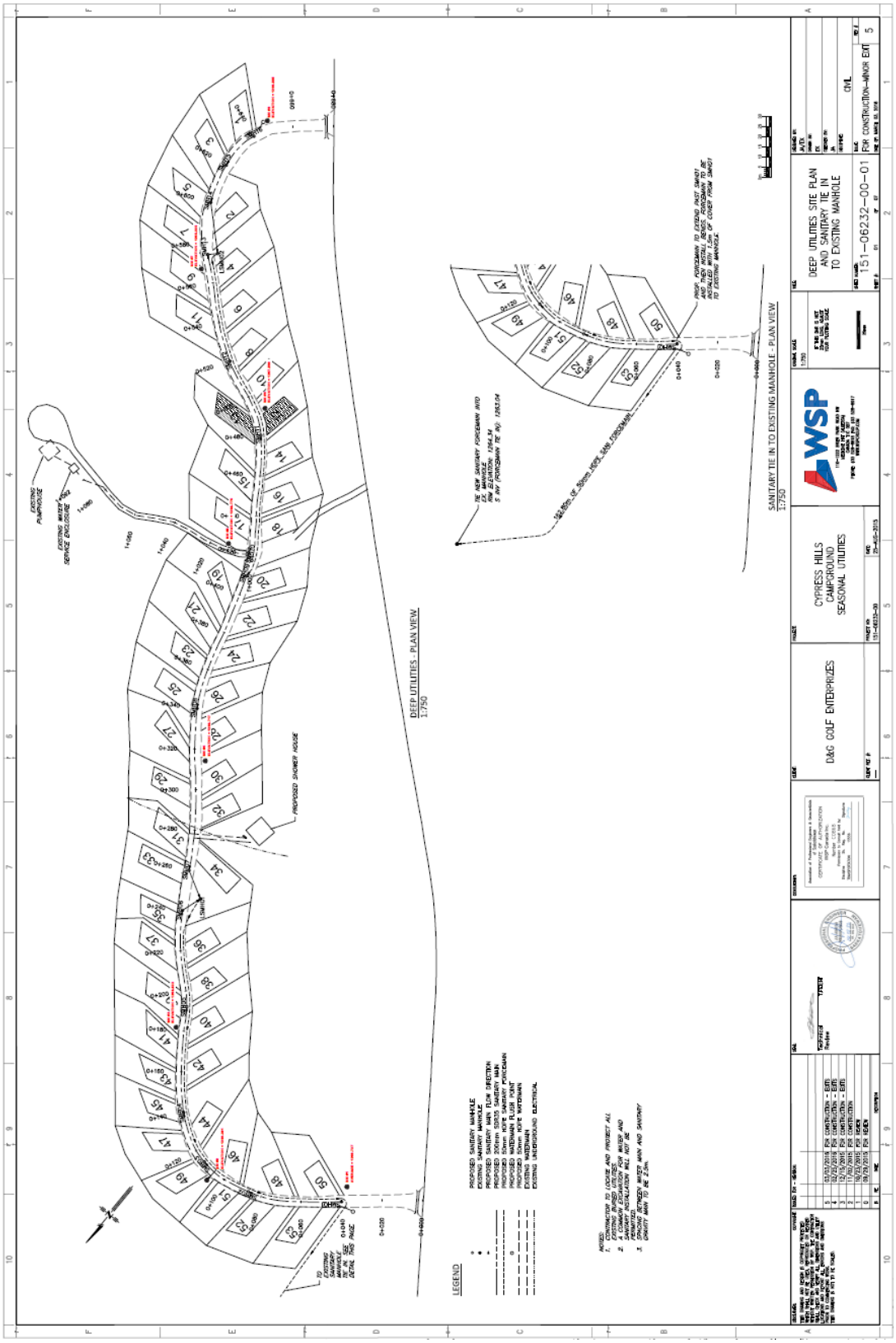
Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Appendix D: Location of Power Line and Redesign Sketch



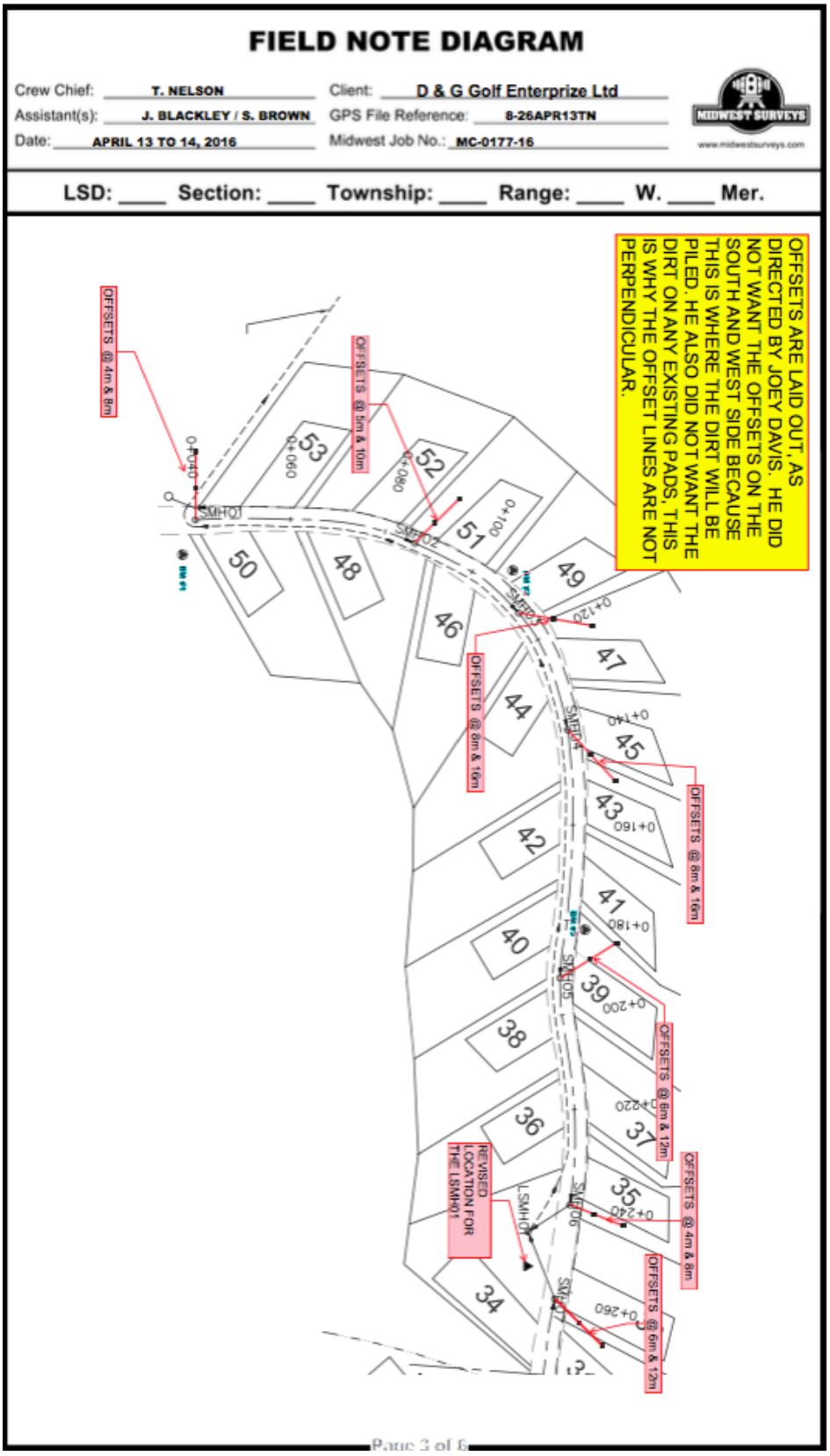
Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Appendix E: Sewer Design Plans Provided by WSP



Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Appendix F: Location of Sewer Offsets and Sewer Benchmarks



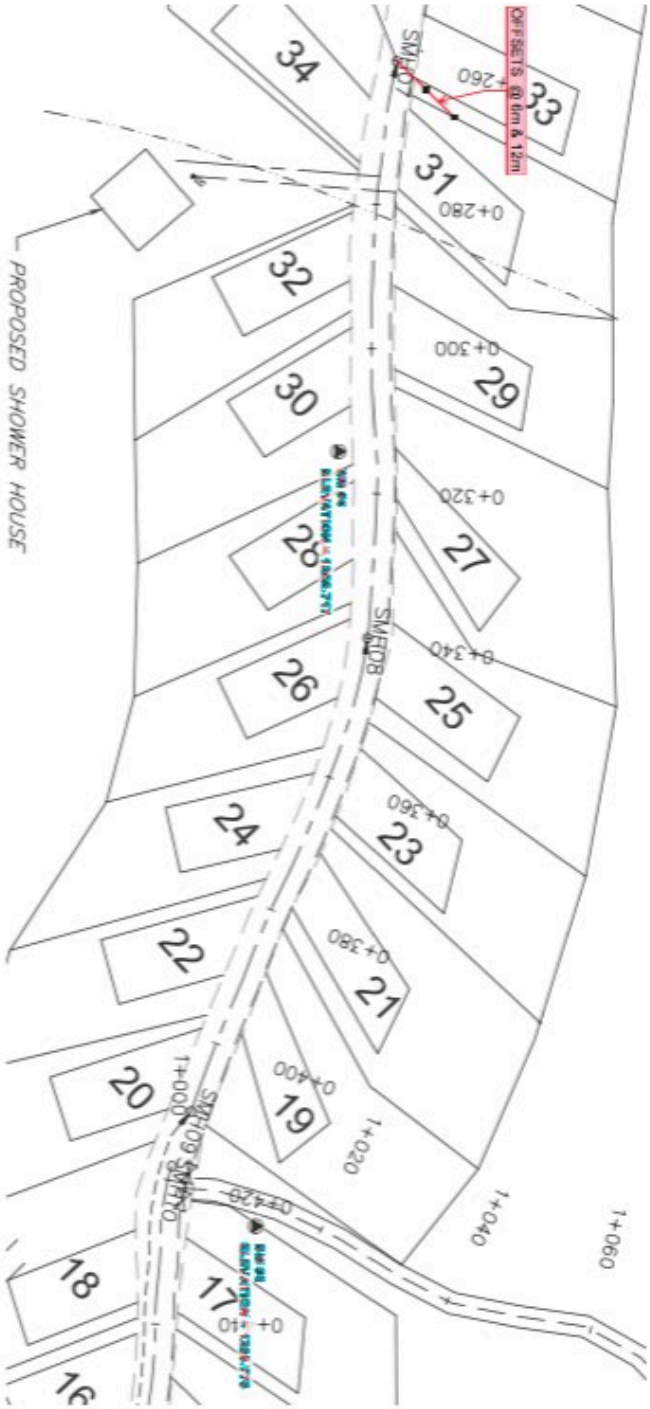
Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

FIELD NOTE DIAGRAM

Crew Chief: T. NELSON
Assistant(s): J. BLACKLEY / S. BROWN
Date: APRIL 13 TO 14, 2016

Client: D & G Golf Enterprize Ltd
GPS File Reference: 8-26APR13TN
Midwest Job No.: MC-0177-16

LSD: ____ Section: ____ Township: ____ Range: ____ W. ____ Mer.



Page 4 of 6

Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

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Crew Chief: T. NELSON
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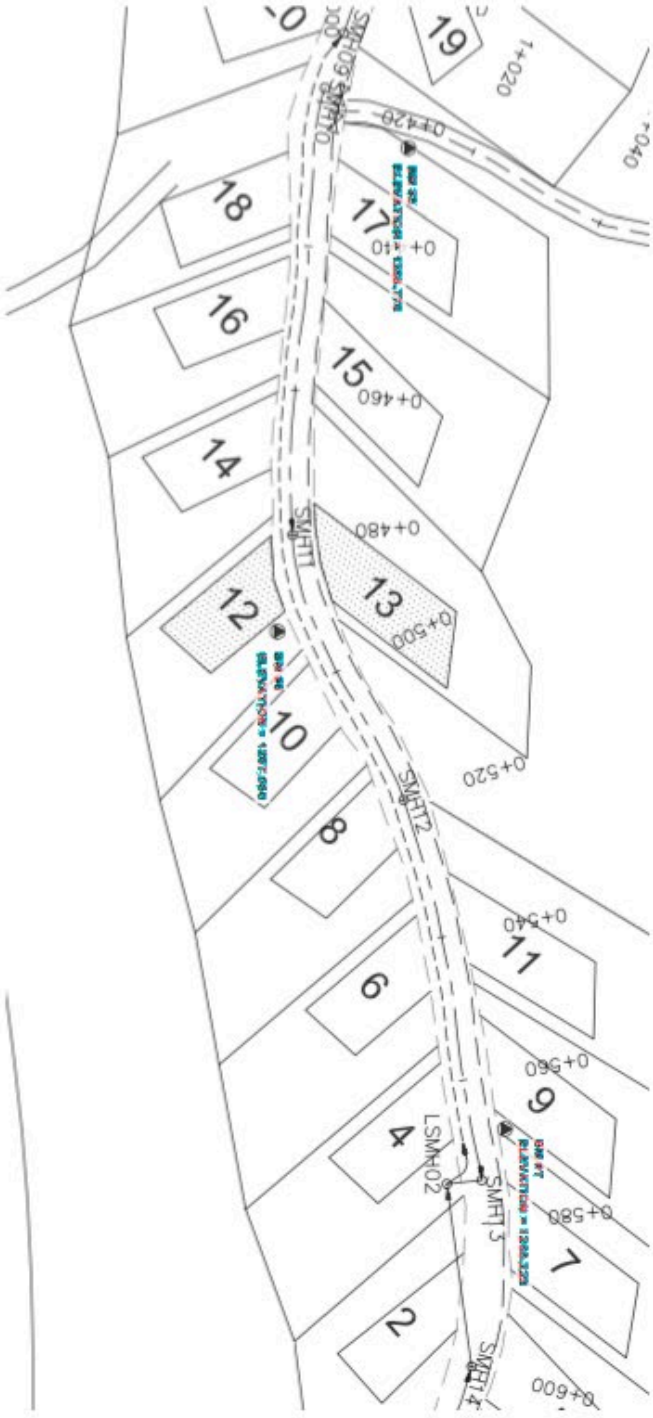
LSD: ____ Section: ____ Township: ____ Range: ____ W. ____ Mer.



Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

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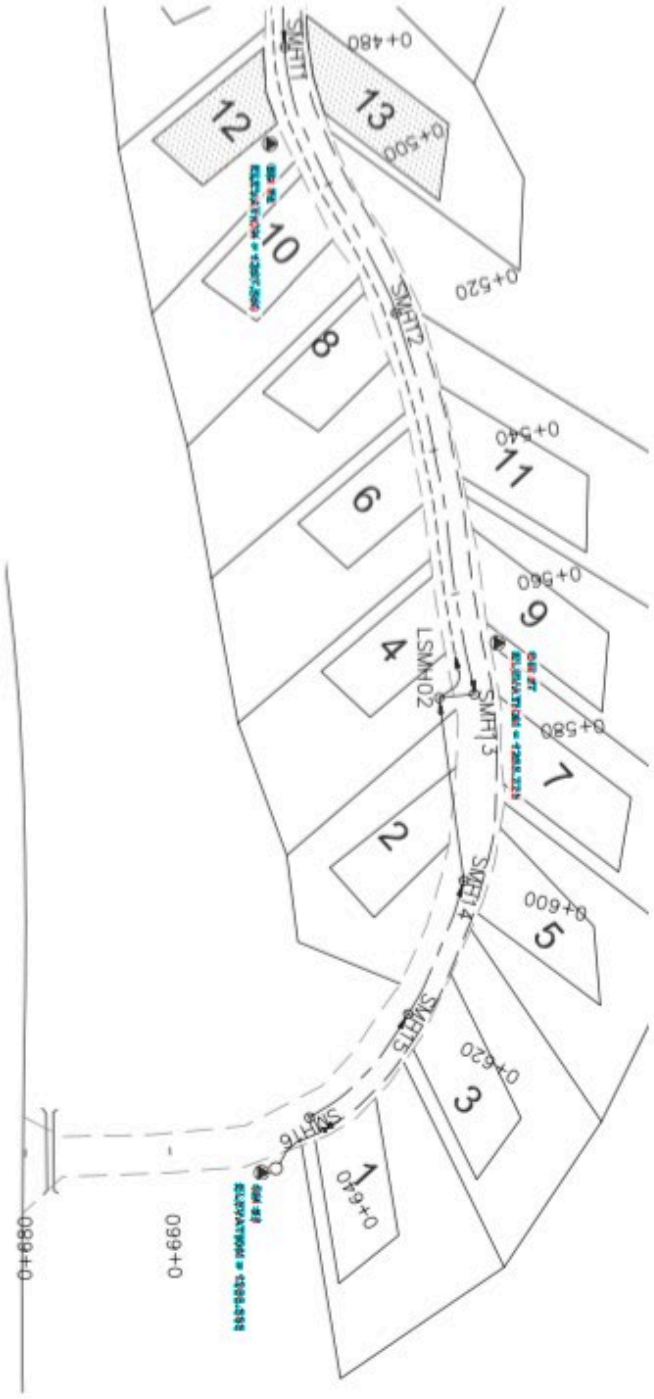
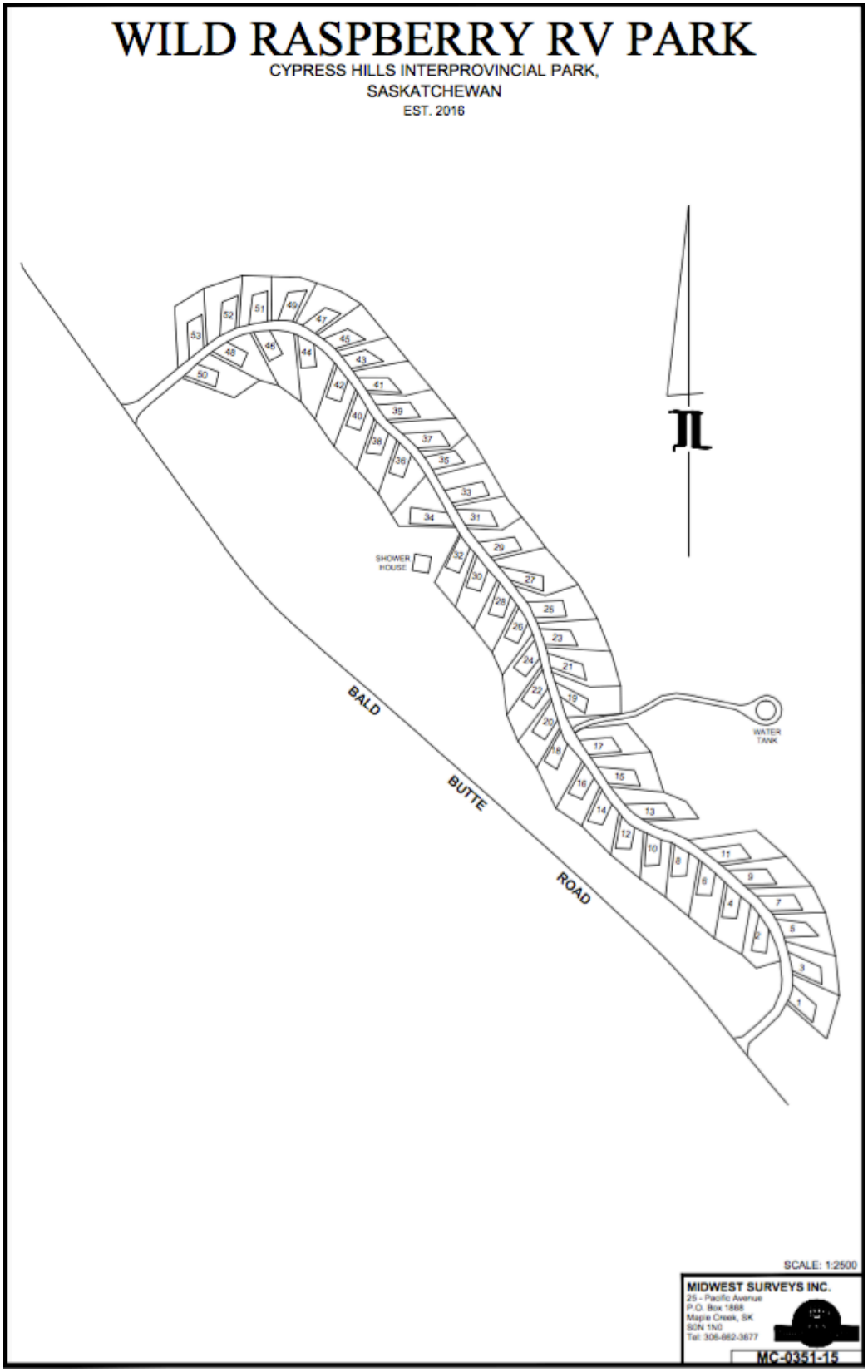
LSD: ____ Section: ____ Township: ____ Range: ____ W. ____ Mer.



Source: T. D. J. Lazar (Personal Communication, April 28, 2016)

Appendix G: Revised Sketch Plan



Source: T. D. J. Lazar (Personal Communication, April 28, 2016)