Underground Injection Control – Class VI Permit Application for Luz Solar No. 1

Liberty County, Texas

SECTION 6 – PLUGGING AND ABANDONMENT PLAN

January 2024

SECTION 6 – PLUGGING PLAN

TABLE OF CONTENTS

6.1 Well Plugging Plan and Regulatory Requirements 2
6.1.1 Well Profile Before Plugging and Abandonment 3
6.1.2 Pre-plugging Activities 4
6.1.3 Plugging Activities 4
6.1.4 Plug Details 5
6.2 Monitoring Well Plugging Plan and Regulatory Requirements 10
6.2.1 Plugging Plan, Rayo Luna No. 1 10
6.2.2 Plugging Plan, [redacted] 18
6.2.3 Plugging Plan, [redacted] 23

Figures

Figure 6-1 – Well Schematic for Luz Solar No. 1 Prior to Plugging and Abandoning 3
Figure 6-2 – Plugging Schematic for Luz Solar No. 1 9
Figure 6-3 – Well Schematic for Rayo Luna No. 1 Before Plugging and Abandoning 11
Figure 6-4 – Plugging Schematic for Rayo Luna No. 1 17
Figure 6-5 – Well Schematic for [redacted] Before Plugging and Abandoning 18
Figure 6-6 – Plugging Schematic for [redacted] 22
Figure 6-7 – Well Schematic for [redacted] Before Plugging and Abandoning 23
Figure 6-8 – Plugging Schematic for [redacted] 27

Tables

Table 6-1 – Casing, Tubing, and Other Well Construction Materials to be Removed for Luz Solar No. 1 4
Table 6-2 – Plugging Details for Luz Solar No. 1: Plug 1 through Plug 6 6
Table 6-3 – Plugging Details for Luz Solar No. 1 – Plug 7 through Plug 12 6
Table 6-4 – Plugging Details for Luz Solar No. 1 – Plug 13 through Plug 18 7
Table 6-5 – Plugging Details for Luz Solar No. 1 – Plug 19 through Plug 24 8
Table 6-6 – Casing, Tubing, and Monitoring Well Construction Materials to be Removed, Rayo Luna No. 1 12
Table 6-7 – Plugging Details for Rayo Luna No. 1: Plug 1 through Plug 6 14
Table 6-8 – Plugging Details for Rayo Luna No. 1: Plug 7 through Plug 12 14
Table 6-9 – Plugging Details for Rayo Luna No. 1: Plug 13 through Plug 18 15
Table 6-10 – Plugging Details for Rayo Luna No. 1: Plug 19 through Plug 24 15
Table 6-11 – Plugging Details for Rayo Luna No. 1: Plug 25 through Plug 30 16
Table 6-12 – Casing, Tubing, and Monitoring Well Construction Materials to be Removed, [redacted] 19
Table 6-13 – Plugging Details for [redacted] 21
Table 6-14 – Casing, Tubing, and Monitoring Well Construction Materials to be Removed, [redacted] 24
Table 6-15 – Plugging Details for [redacted] 26

6.1 Well Plugging Plan and Regulatory Requirements

This plan for the proposed injection well Luz Solar No. 1 was prepared to meet the requirements of Texas Administrative Code (TAC) **§5.203(k)** [Title 40, US Code of Federal Regulations (40 CFR) **§146.92**]. This plan provides the steps that will be taken to plug and abandon the planned stages of well development, including final abandonment. Any plugging activities required for the monitoring wells associated with this project are also discussed. Complete plugging and abandonment (P&A) prognoses have been included in *Appendix H – Plugging and Abandonment.*

As described in *Section 4 – Engineering Design and Operating Strategy*, the well will be completed with multiple injection zones within the gross injection interval. Each injection zone will be used for a discrete period as identified in the CO_2 plume model and operating plans. Once an active injection zone has been exhausted of its CO_2 storage capabilities, that zone will be plugged to prevent crossflow conditions between new and existing injection zones. Then, once the exhausted sand package has been plugged, a new injection zone uphole will be perforated and opened for injection. This process will be repeated until the entire gross injection interval has been fully developed. After approximately [redacted] years of injection, or when available storage capacity has been fully utilized, the well will be permanently plugged and abandoned.

The following details outline the procedures for both types of plugs to be installed in this well. In summary, the two types of plugs are as follows:

1. Isolation of the active injection section by way of recompletion operations
2. Final P&A of the well

6.1.1 Well Profile Before Plugging and Abandonment

Figure 6-1 shows the well schematic for Luz Solar No. 1 prior to plugging operations.

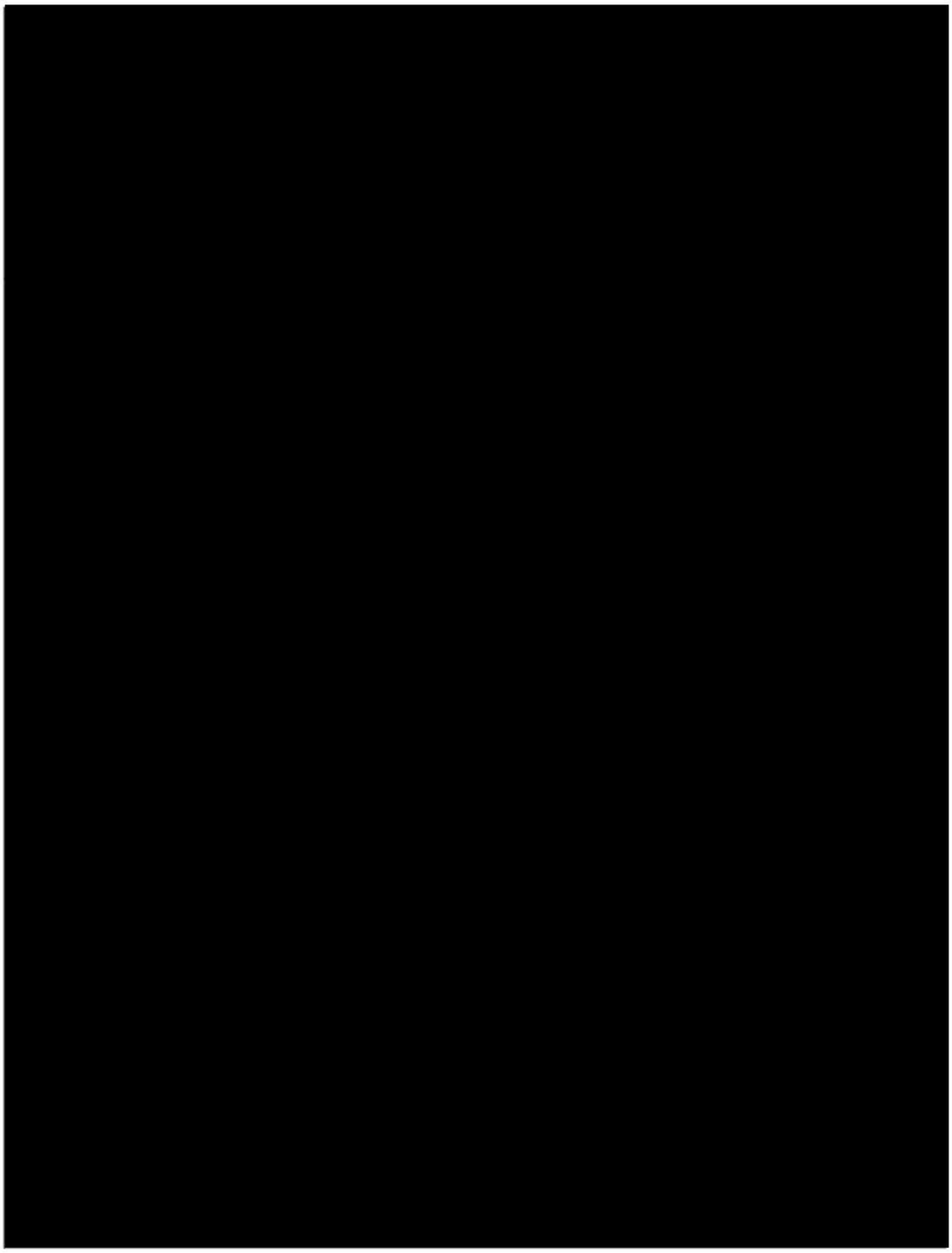

Figure 6-1 – Well Schematic for Luz Solar No. 1 Prior to Plugging and Abandoning

6.1.2 Pre-plugging Activities

1. BKVerde, LLC (BKVerde) will comply with all reporting and notification provisions.
   a. The EPA Underground Injection Control (UIC) Program director (UIC Director) will be notified 60 days in advance of planned plugging efforts. [40 CFR **§146.92(c)**]
   b. The Texas Railroad Commission (TRRC) and the UIC Director will be notified at least 60 days before plugging a well. If any changes are proposed to the original well-plugging plan, a revised plan will be submitted. (16 TAC **§5.201(k)(3)(A)**)
   c. A notice of intention to plug and abandon (Form W-3A) will be filed with the appropriate TRRC district office and the UIC Director at least 5 days before beginning plugging operations.
   d. Plugging operations will not start until the UIC Director approves the proposed procedure.
   e. The appropriate TRRC district office will be notified at least 4 hours before commencing plugging operations.
2. Casing inspection and cement bond logs will be run before plugging.
3. Bottomhole reservoir pressure will be measured using the downhole pressure gauges permanently installed behind the [redacted] inch (in.) tubing. Details for this system are provided in *Section 5 – Testing and Monitoring Plan*. (16 TAC **§5.203(h)(1)(C)** [40 CFR **§146.89(b)**])
4. External mechanical integrity will be demonstrated through approved temperature logging methods, as described in *Section 5*, in accordance with 16 TAC **§5.203(h)(1)(D)** [40 CFR **§146.89(c)**].
5. Luz Solar No. 1 will be flushed with a buffer fluid before pulling the injection tubing and packer. (16 TAC **§5.203** and **§3.14** [40 CFR **§146.92(a)**])
6. All uncemented, nonpermanent well components will be removed as listed in Table 6-1.

Table 6-1 – Casing, Tubing, and Other Well Construction Materials to be Removed for Luz Solar No. 1

Well Component	Size (in.)	Amount (ft)	Notes/Comments
[redacted]			

6.1.3 Plugging Activities

The summary procedure is as follows. A full plugging procedure is included in *Appendix H-1.*

1. After pressure testing the annulus, the well will be flushed with kill-weight fluid. The tubing and packer will be removed.
2. The gross injection interval will be fully isolated.

a. [redacted]
b. The plug will be qualified by tagging the top and conducting a successful pressure test.
c. The well will be filled with at least 9.5 pounds per gallon (ppg), 40-viscosity, treated water-based mud.

[redacted]

8. A balanced Class A cement plug will then be set from 6 to 26 ft.
9. Casing will be cut 6 ft below plow level, a 20-ft cement plug will be set from 6 to 26 ft, and a ½-in. steel plate with the well serial number welded on.

Within 60 days after plugging, BKVerde will submit to the UIC Director, pursuant to 40 CFR **§146.91(e)**, a certified well-plugging report—which will be retained for 10 years following site closure. Also note that a complete well-plugging record (Form W-3), pursuant to 16 TAC **§5.203**, will be filed within 30 days to the appropriate TRRC district office after plugging operations are completed.

6.1.4 Plug Details

Tables 6-2 through 6-5 show the planned plugging details for Luz Solar No. 1. Figure 6-2 shows a schematic of Luz Solar No. 1 after the well is plugged.

Table 6-2 – Plugging Details for Luz Solar No. 1: [redacted]

Plug Number	[redacted]
Purpose	
Casing OD[4] (in.)	
Casing ID[5] (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)[6]	
Slurry Weight (lb/gal[7])	
Type of Cement or Other Material	
Placement	

[1]CRC – CO_2-resistant cement
[2]CRBP – corrosion resistant bridge plug
[3]CTU – coil tubing unit
[4]OD – outside diameter
[5]ID – inside diameter
[6] ft^3 – cubic feet
[7] lb/gal – pounds per gallon

Table 6-3 – Plugging Details for Luz Solar No. 1 – [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	

Plug Number	[redacted]
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

Table 6-4 – Plugging Details for Luz Solar No. 1 – [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

Table 6-5 – Plugging Details for Luz Solar No. 1 – [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

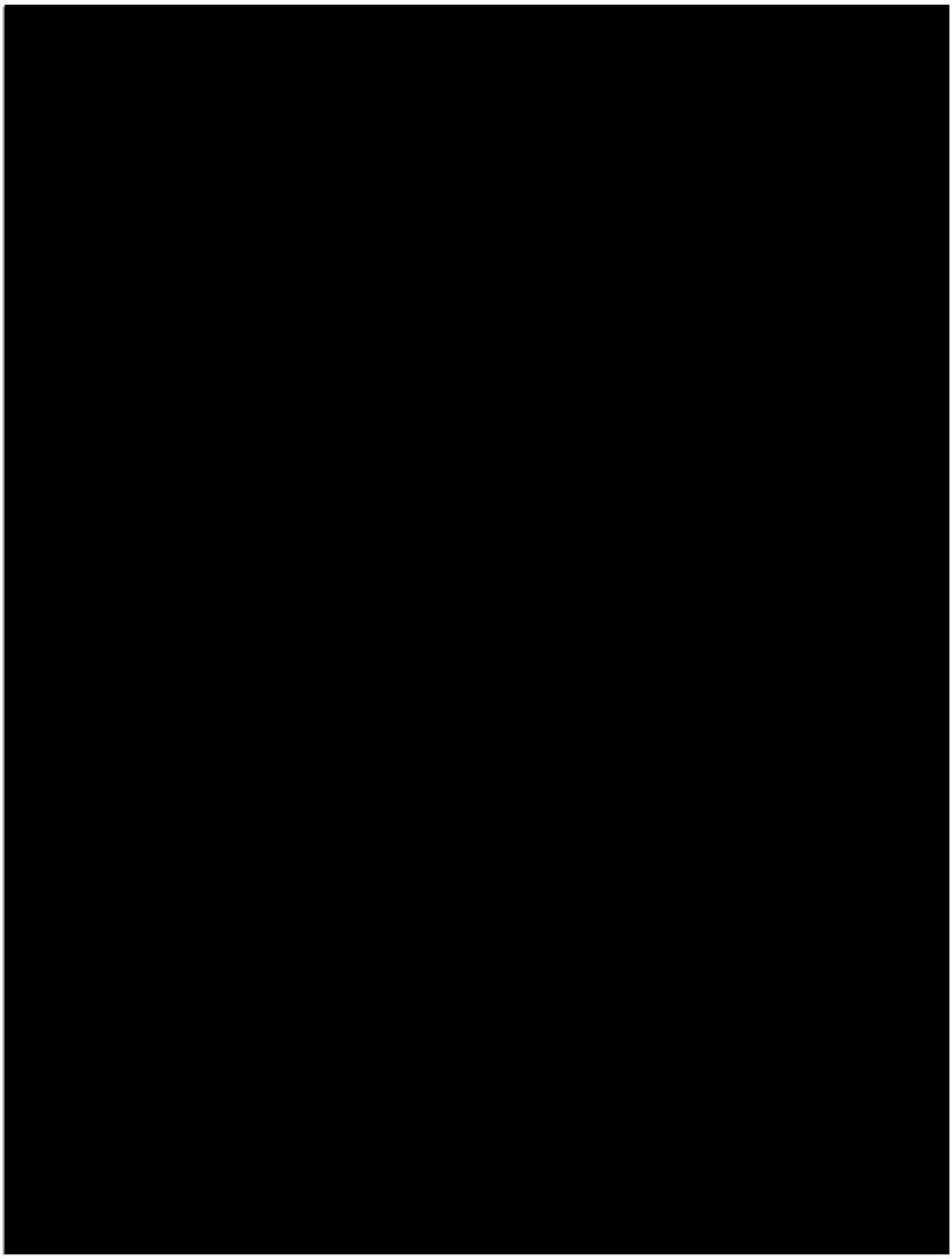

Figure 6-2 – Plugging Schematic for Luz Solar No. 1

6.2 Monitoring Well Plugging Plan and Regulatory Requirements

As described in *Section 4 – Engineering Design and Operating Strategy*, Rayo Luna No. 1 will be completed as an in-zone monitoring well. [redacted]

Complete P&A prognoses for these two wells are provided in *Appendices H-5* and *H-7*. At the conclusion of the post-injection site care period, the wells will be permanently plugged.

The following outline describes the procedures and types of plugs that will be set to isolate the perforated interval and to prevent contamination of the USDW. All wells will be properly plugged and abandoned according to 16 TAC **§5.203** and **§3.14** [40 CFR **§146.92**] regulations.

6.2.1 Plugging Plan, Rayo Luna No. 1

6.2.1.1 Monitoring Well Profile Before Plugging and Abandonment, Rayo Luna No. 1

The original well schematic for Rayo Luna No. 1, an in-zone monitoring well profile before beginning plugging operations, is provided in Figure 6-3.

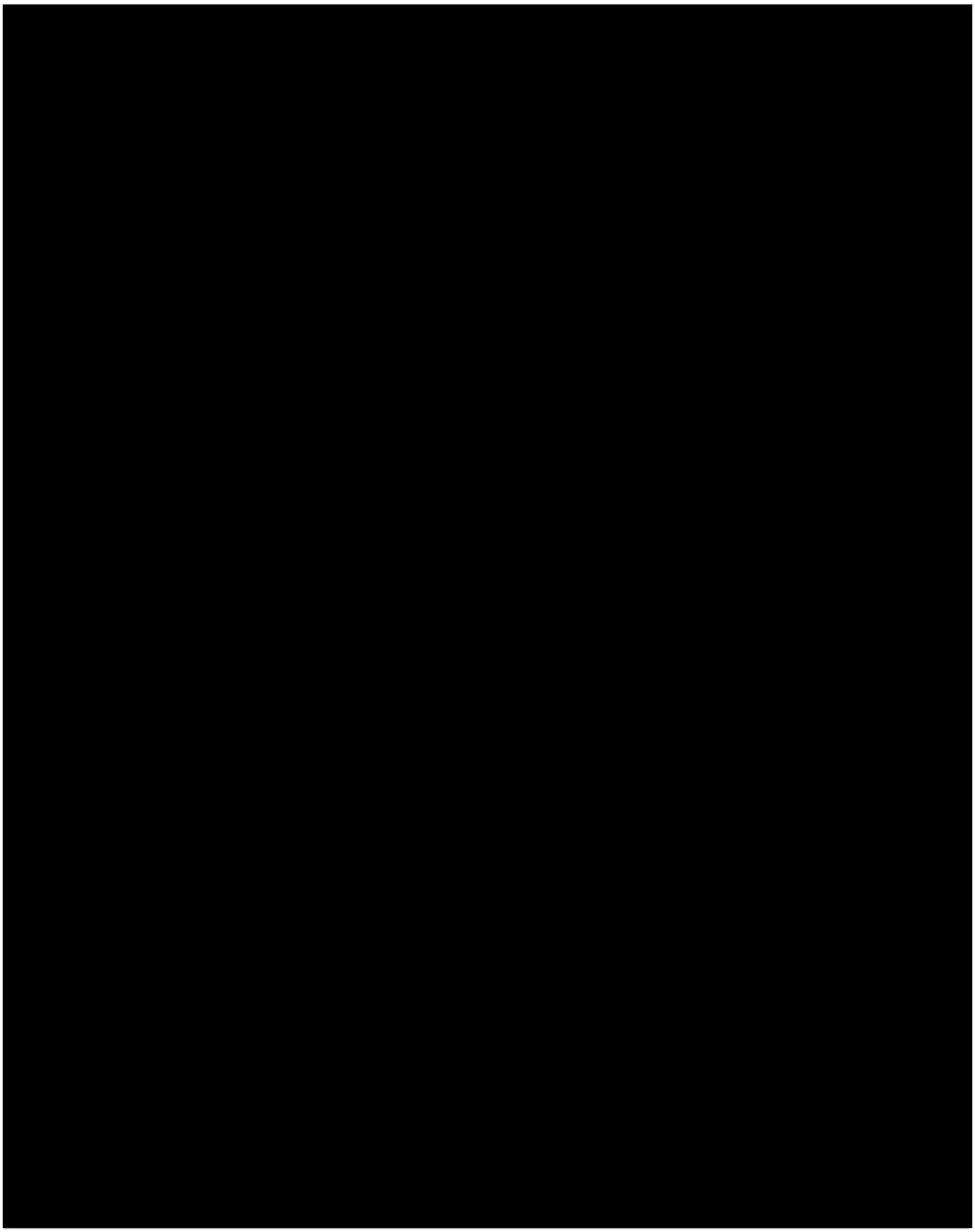

Figure 6-3 – Well Schematic for Rayo Luna No. 1 Before Plugging and Abandoning

6.2.1.2 Monitoring Well Pre-plugging Activities, Rayo Luna No. 1

1. BKVerde will comply with all reporting and notification provisions.
   a. The UIC Director will be notified 60 days in advance of planned plugging efforts. [40 CFR **§146.92(c)**]
   b. The TRRC and the UIC Director will be notified at least 60 days before plugging a well. If any changes are proposed to the original well-plugging plan, a revised plan will be submitted. (16 TAC **§5.201(k)(3)(A)**)
   c. A notice of intention to plug and abandon (Form W-3A) will be filed with the appropriate TRRC district office and the UIC Director at least 5 days before the beginning of plugging operations.
   d. Plugging operations will not start until the proposed procedure has been approved by the UIC Director.
   e. The district office will be notified at least 4 hours before commencing plugging operations.
2. Casing inspection and cement bond logs will be run before plugging.
3. External mechanical integrity will be demonstrated through approved temperature logging methods, as described in *Section 5 – Testing and Monitoring Plan*, in accordance with 16 TAC **§5.203(h)(1)(D)** [40 CFR **§146.89(c)**].
4. Rayo Luna No. 1 will be flushed with a buffer fluid before pulling the injection tubing and packer seal assembly. (16 TAC **§5.203** and **§3.14** [40 CFR **§146.92(a)**])
5. All uncemented, nonpermanent components of the well will be removed, as listed in Table 6-6.

Table 6-6 – Casing, Tubing, and Monitoring Well Construction Materials to be Removed, Rayo Luna No. 1

Well Component	Size (in.)	Amount (ft)	Notes/Comments
[redacted]			

6.2.1.3 Plugging Activities

1. After pressure testing the annulus, the well will be flushed with kill-weight fluid. The tubing and packer will be removed.
2. The gross injection interval will be fully isolated.
   [redacted]
   b. The plug will be qualified by tagging the top and conducting a successful pressure test.
   c. The well will be filled with at least 9.5-ppg, 40-viscosity, treated drilling mud—and the well's static condition ensured.

[redacted]

8. Casing will be cut 6 ft below plow level and a ½-in. steel plate with the well serial number welded on.

Within 60 days after plugging, BKVerde will submit to the UIC Director, pursuant to 40 CFR **§146.91(e)**, a certified well-plugging report—which will be retained for 10 years following site closure. Also note that a complete well-plugging record (Form W-3), pursuant to 16 TAC **§5.203**, will be filed within 30 days to the appropriate TRRC district office, after plugging operations are completed.

6.2.1.4 Plug Details

The summary for each plug is provided in Tables 6-7 through 6-11, while the P&A schematic is shown in Figure 6-4.

Table 6-7 – Plugging Details for Rayo Luna No. 1: [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

Table 6-8 – Plugging Details for Rayo Luna No. 1: [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

Table 6-9 – Plugging Details for Rayo Luna No. [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

Table 6-10 – Plugging Details for Rayo Luna No. 1: [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	

Plug Number	[redacted]
Type of Cement or Other Material	
Placement	

Table 6-11 – Plugging Details for Rayo Luna No. 1: [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

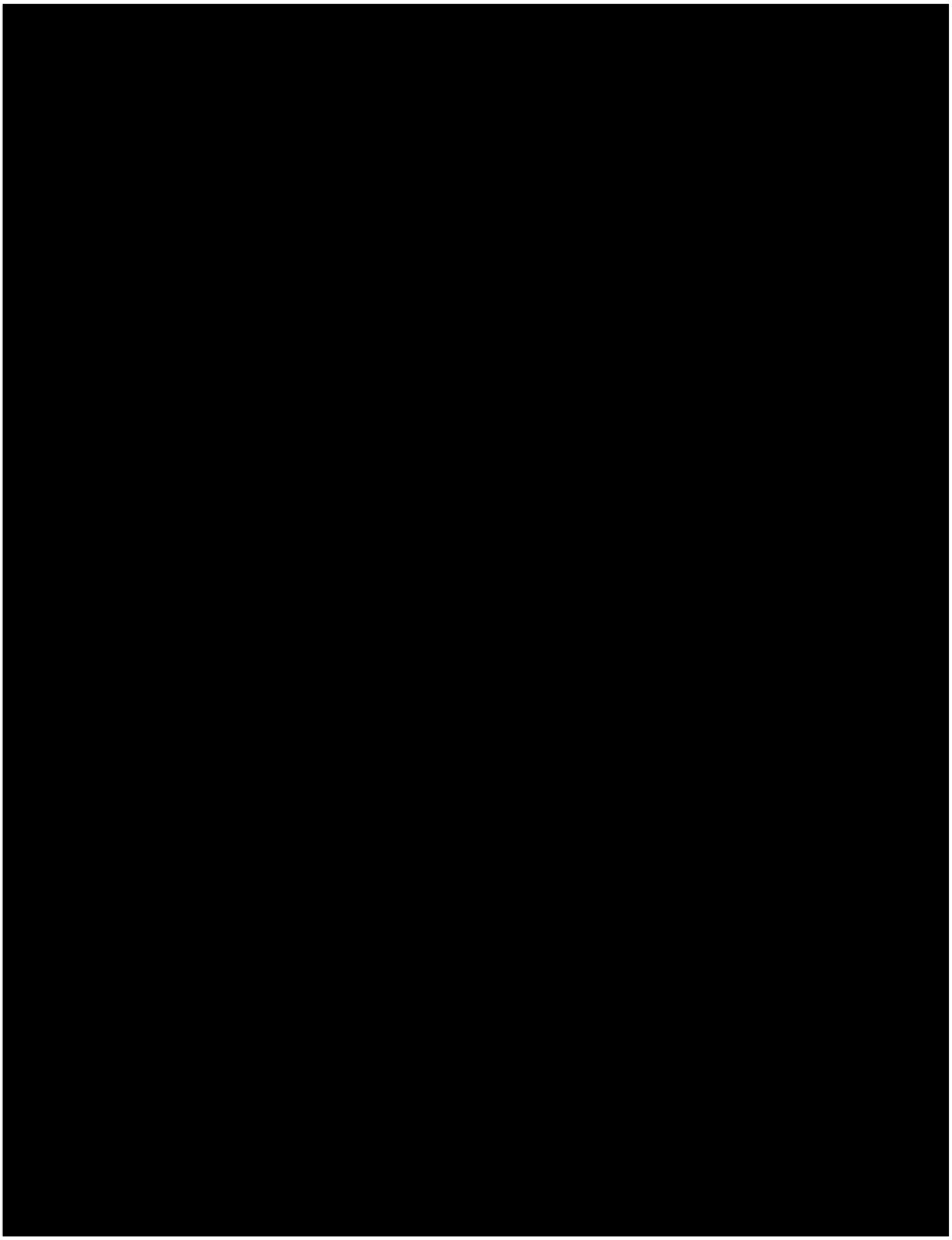

Figure 6-4 – Plugging Schematic for Rayo Luna No. 1

6.2.2 Plugging Plan, [redacted]

6.2.2.1 Monitoring Well Profile Before Plugging and Abandonment, [redacted]

The original well schematic for [redacted], before beginning plugging operations, is provided in Figure 6-5.

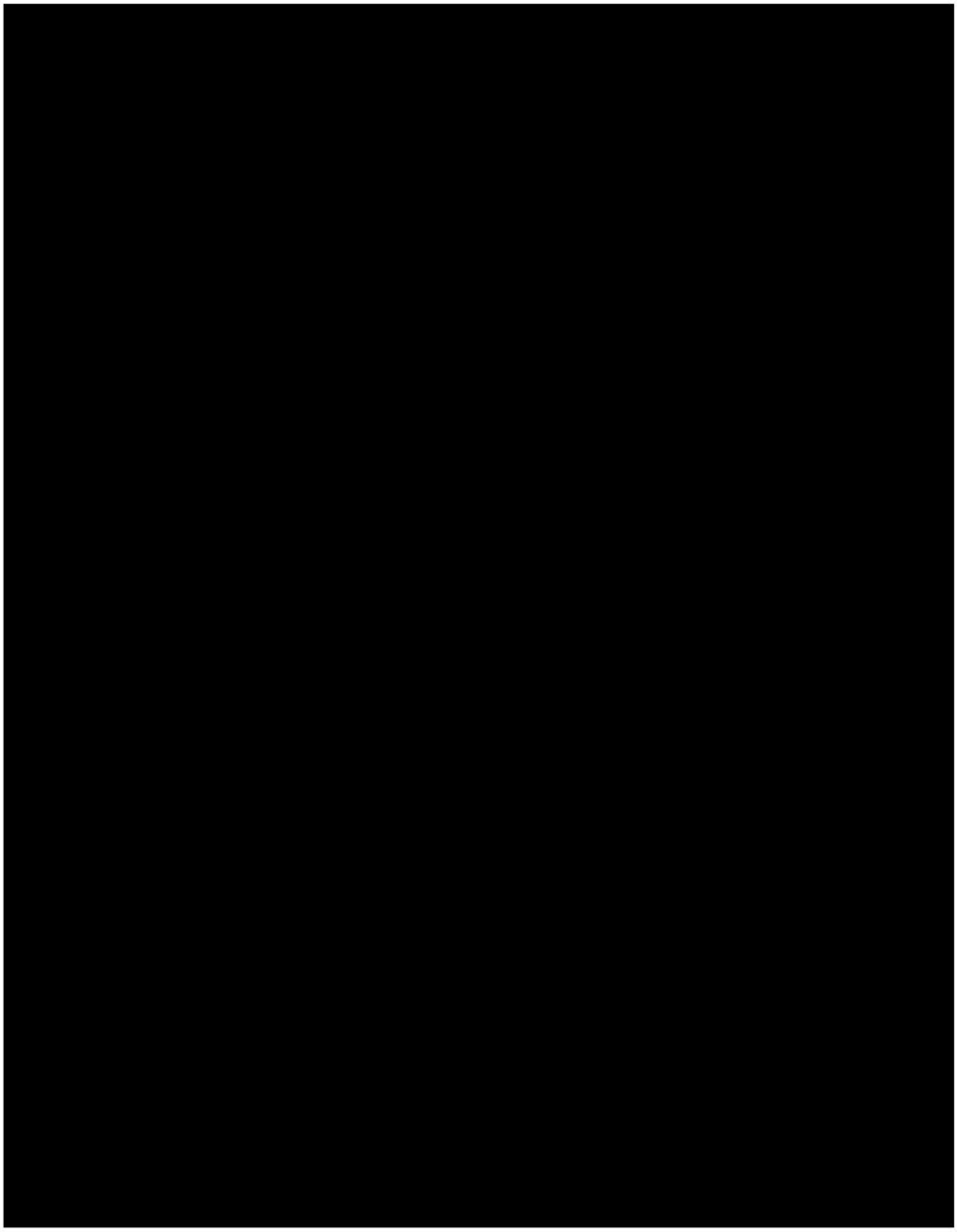

Figure 6-5 – Well Schematic for [redacted] Before Plugging and Abandoning

6.2.2.2 Monitoring Well Pre-plugging Activities, [redacted]

1. BKVerde will comply with all reporting and notification provisions.
   a. The UIC Director will be notified 60 days in advance of planned plugging efforts. [40 CFR **§146.92(c)**]
   b. The TRRC and the UIC Director will be notified at least 60 days before plugging the well. If any changes are proposed to the original well-plugging plan, a revised plan will be submitted. (16 TAC **§5.201(k)(3)(A)**)
   c. A notice of intention to plug and abandon (Form W-3A) will be filed with the appropriate TRRC district office and the UIC Director at least 5 days before the beginning of plugging operations.
   d. Plugging operations will not start until the proposed procedure has been approved by the UIC Director.
   e. The district office will be notified at least 4 hours before commencing plugging operations.
2. Casing inspection and cement bond logs will be run before plugging.
3. External mechanical integrity will be demonstrated through approved temperature logging methods, as described in *Section 5 – Testing and Monitoring Plan*, in accordance with 16 TAC **§5.203(h)(1)(D)** [40 CFR **§146.89(c)**].
4. [redacted] will be flushed with a buffer fluid before pulling the injection tubing and packer seal assembly. (16 TAC **§5.203** and **§3.14** [40 CFR **§146.92(a)**])
5. All uncemented, nonpermanent components of the well will be removed, as listed in Table 6-12.

Table 6-12 – Casing, Tubing, and Monitoring Well Construction Materials to be Removed, [redacted]

Well Component	Size (in.)	Amount (ft)	Notes/Comments
[redacted]			

6.2.2.3 Plugging Activities

1. After pressure testing the annulus, the well will be flushed with kill-weight fluid. The tubing and packer will be removed.
2. The gross monitoring interval will be fully isolated.
3. The well will be filled with at least 9.5-ppg, 40-viscosity, treated drilling mud—and the well's static condition ensured.
4. A balanced cement plug will be set across the USDW from 1,800 to 2,100 ft.

[redacted]

[redacted]

10. A balanced plug will be spotted from 6 to 26 ft.
11. Casing will be cut 6 ft below plow level and a ½-in. steel plate with the well serial number welded on.

The summary for each plug is provided in Table 6-16, and the P&A schematic is shown in Figure 6-6.

Within 60 days after plugging, BKVerde will submit to the UIC Director, pursuant to 40 CFR **§146.91(e)**, a certified well-plugging report—which will be retained for 10 years following site closure. Also note that a complete well-plugging record (Form W-3), pursuant to 16 TAC **§5.203**, will be filed within 30 days to the appropriate TRRC district office after plugging operations are completed.

6.2.2.4 Plug Details

[redacted]

Table 6-13 – Plugging Details for [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (Sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

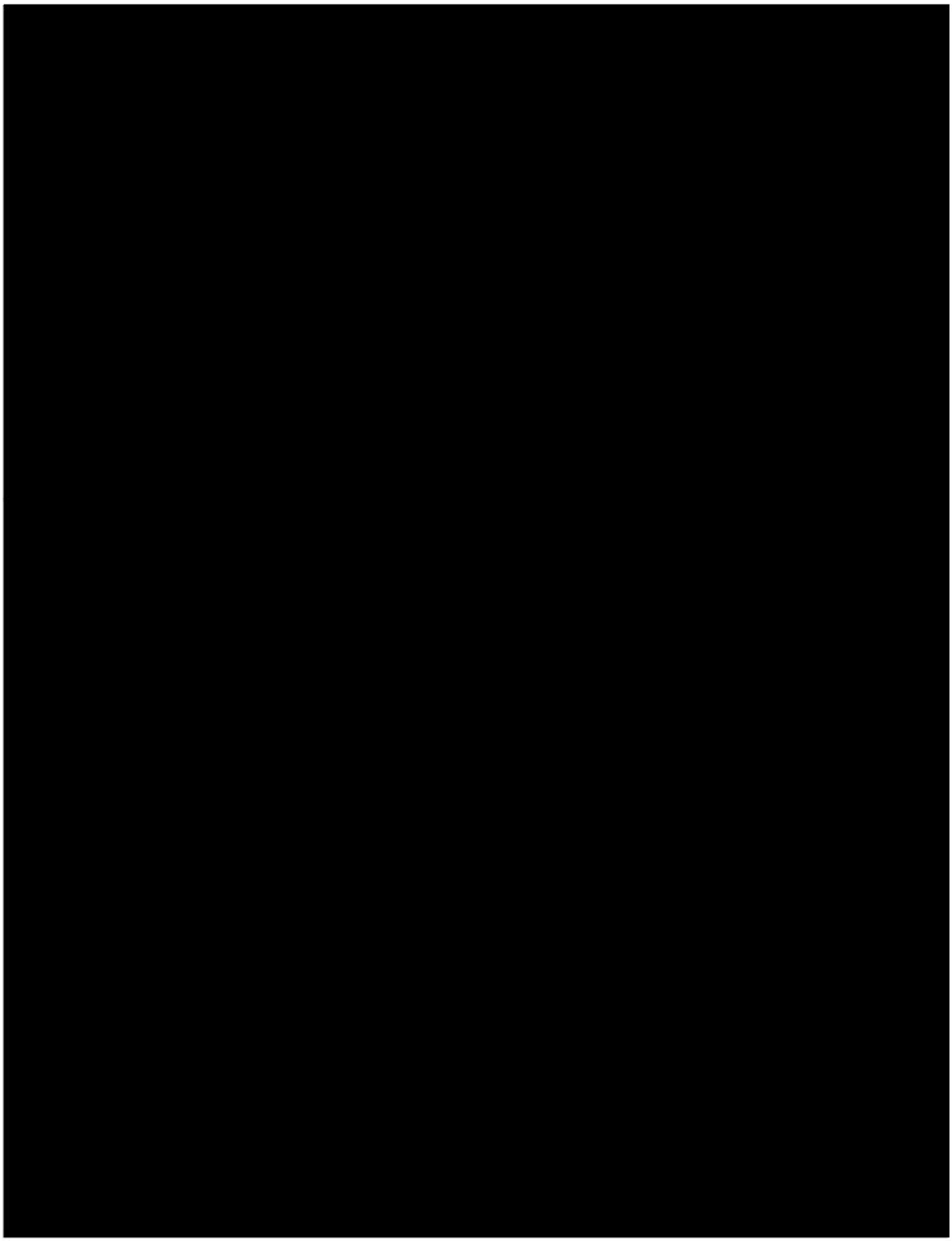

Figure 6-6 – Plugging Schematic for [redacted]

6.2.3 Plugging Plan, [redacted]

6.2.3.1 USDW Monitoring Well Profile Before Plugging and Abandonment, [redacted]

The original well schematic for [redacted] before beginning plugging operations, is provided in Figure 6-7.

[redacted]

Figure 6-7 – Well Schematic for [redacted] Before Plugging and Abandoning

6.2.3.2 Monitoring Well Pre-plugging Activities, [redacted]

1. BKVerde will comply with all reporting and notification provisions.
   a. The UIC Director will be notified 60 days in advance of planned plugging efforts. [40 CFR **§146.92(c)**]
   b. The TRRC and the UIC Director will be notified at least 60 days before plugging a well. If any changes are proposed to the original well-plugging plan, a revised plan will be submitted. (16 TAC **§5.201(k)(3)(A)**)
   c. A notice of intention to plug and abandon (Form W-3A) will be filed with the appropriate TRRC district office and the UIC Director at least 5 days before the beginning of plugging operations.
   d. Plugging operations will not start until the proposed procedure has been approved by the UIC Director.
   e. The district office will be notified at least 4 hours before commencing plugging operations.
2. Casing inspection and cement bond logs will be run before plugging.
3. External mechanical integrity will be demonstrated through approved temperature logging methods, as described in *Section 5 – Testing and Monitoring Plan*, in accordance with 16 TAC **§5.203(h)(1)(D)** [40 CFR **§146.89(c)**].
4. The Frost/Keenan No. 1 will be flushed with a buffer fluid before pulling the injection tubing and packer seal assembly. (16 TAC **§5.203** and **§3.14** [40 CFR **§146.92(a)**])
5. All uncemented, nonpermanent components of the well will be removed, as listed in Table 6-14.

Table 6-14 – Casing, Tubing, and Monitoring Well Construction Materials to be Removed, [redacted]

Well Component	Size (in.)	Amount (ft)	Notes/Comments
[redacted]			

6.2.3.3 Plugging Activities

1. After pressure testing the annulus, the well will be flushed with kill-weight fluid. The tubing and packer will be removed.
2. The gross monitoring interval will be fully isolated. [redacted]
   c. The well will be filled with at least 9.5 ppg, 40 viscosity, treated drilling mud—and the well's static condition ensured.

[redacted].

11. A balanced 20-ft cement plug will be spotted from 6 to 26 ft.
12. Casing will be cut 6 ft below plow level and a ½-in. steel plate with the well serial number welded on.

The summary for each plug is provided in Table 6-15, and the P&A schematic is shown in Figure 6-8.

Within 60 days after plugging, BKVerde will submit, pursuant to 40 CFR **§146.91(e)**, a certified plugging report to the UIC Director. The well-plugging report will be retained for 10 years following site closure. Also note that a complete well-plugging record (Form W-3), pursuant to 16 TAC **§5.203**, will be filed within 30 days to the appropriate TRRC district office after plugging operations are completed.

6.2.3.4 Plug Details

[redacted] after the well is plugged, is shown in Figure 6-8.

Table 6-15 – Plugging Details for [redacted]

Plug Number	[redacted]
Purpose	
Casing OD (in.)	
Casing ID (in.)	
Top of Plug (ft)	
Bottom of Plug (ft)	
Cement Volume (sacks)	
Slurry Volume (ft^3)	
Slurry Weight (lb/gal)	
Type of Cement or Other Material	
Placement	

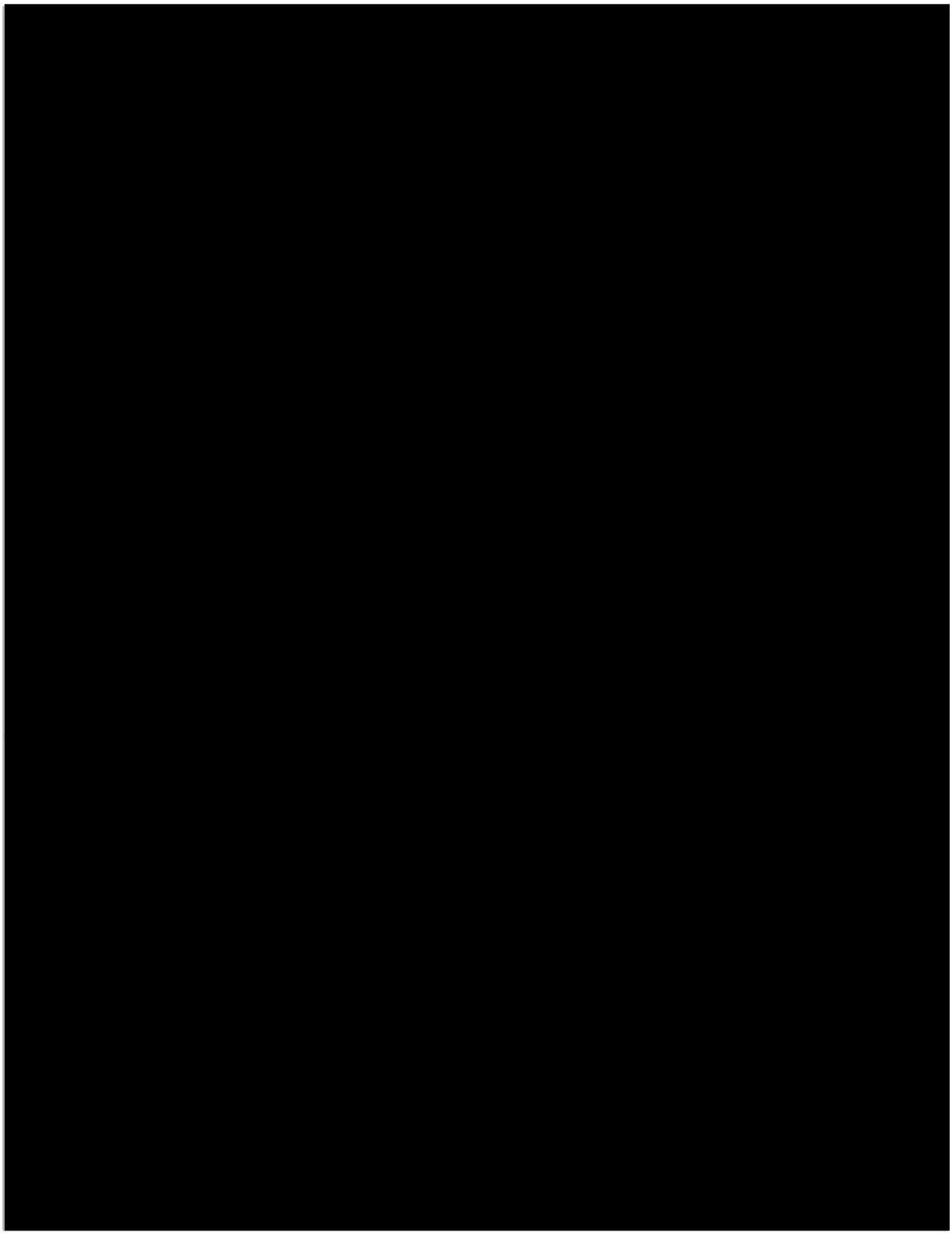

Figure 6-8 – Plugging Schematic for [redacted]

Detailed schematics and procedures are in *Appendix H – Plugging and Abandonment*:

- Appendix H-1 Luz Solar No. 1 – Plugging Procedure
- Appendix H-2 Luz Solar No. 1 – Plugged Well Schematic
- Appendix H-3 Rayo Luna No. 1 – Plugging Procedure
- Appendix H-4 Rayo Luna No. 1 – Plugged Well Schematic
- Appendix H-5 [redacted] Plugging Procedure
- Appendix H-6 [redacted] – Plugged Well Schematic
- Appendix H-7 [redacted] Plugging Procedure
- Appendix H-8 [redacted] Plugged Well Schematic