APPENDIX B

Proposed Well Construction Procedures and Diagrams

ATTACHMENT L

CONSTRUCTION PROCEDURES

TABLE OF CONTENTS

1. INTRODUCTION

This Attachment was prepared in support of Excelsior Mining Arizona, Inc.'s (Excelsior's) Underground Injection Control (UIC) Permit application to the United States Environmental Protection Agency (USEPA). Excelsior is applying for an area Class III UIC permit to install a wellfield for in-situ recovery (ISR) of copper at the Gunnison Copper Project (Project), located in Cochise County, Arizona. This Attachment documents proposed well construction procedures. Schematic drawings of the proposed well designs are provided in Attachment M.

This project meets the criteria for an area permit, as described in Chapter 40 of the Code of Federal Regulations §144.33 because:

- The injection wells will be within the same well field, facility site, reservoir, and project;
- The wells will be operated by a single owner or operator;
- The wells will not be used to inject hazardous waste;
- The injection wells will not be Class IV wells.

The construction procedures described in this attachment are compliant with the requirements of §146.32 for Class III injection wells. This attachment does not include a description of downhole equipment such as submersible pumps, injection tubing, fluid level instruments, and other equipment that can be installed and removed from a well at any time after the well is installed.

Wells installed at the Project will include injection, recovery, hydraulic control, observation wells, and point-of-compliance (POC) monitoring wells. The wells will be constructed to meet Class III requirements. Varying well designs are proposed, as shown in Attachment M. The injection, recovery, and hydraulic control wells are proposed to have open-hole completions within the ore body, which ranges from approximately 50 to 1250 feet in thickness. Observation wells and POC wells will be constructed with well screen. The depths of the well screens to be installed in the observation and POC wells will be equivalent to the open-hole or screened completion intervals in the nearest injection, recovery, and hydraulic control wells.

2. DRILLING AND CONSTRUCTION

2.1 Surface Casing

A surface casing (low carbon steel manufactured in accordance with ASTM Specification 153-89A Grade A or better) will be installed to support the ground surface during drilling. The surface casing will be of sufficient diameter to allow for drilling of the borehole (Section 2.2). It is expected, based on the well designs presented in Attachment M, that 14-inch nominal diameter (minimum) will be used for the small diameter injection/recover/hydraulic control wells, 16-inch nominal diameter (minimum) will be used for the large diameter injection/recovery well, and 10-inch nominal diameter (minimum) for the observation wells and POC wells. Surface casing will be installed to a depth of 20 feet below grade and the annulus will be cemented. The minimum length of the surface casing will be 21 feet, to allow for a minimum 1-foot stickup above land surface.

2.2 Borehole

Boreholes will be drilled using air rotary, direct mud rotary, reverse circulation mud rotary, or casing advance drilling methods. The wells will be drilled in two stages: the upper stage will consist of a boring drilled from land surface through basin fill into competent bedrock or 20 feet below the bedrock surface, whichever is greater. After the casing for the first stage is cemented in place, a smaller diameter borehole will be drilled into the bedrock to total depth. In most cases, the borehole within the bedrock interval will remain open. If boreholes are found to be unstable, screen may be installed in the bedrock section to keep the borehole open. The decision to install screen will be made in the field, based on field observations. Annular materials in the screened interval are not proposed but may be used based on field conditions.

Borehole diameters will be sufficient to allow for installation of casing that will accommodate the pumps and other downhole equipment. The cased portions of the boreholes will be 12-inch nominal (small diameter injection/recovery wells and hydraulic control wells), 15-inch nominal (large diameter injection/recovery wells), and 10-inch nominal (observation and POC wells). The open borehole sections within bedrock will be 5- and 7-inch nominal.

2.3 Casing

Casing strings (including screen if the well will have screened completion) will be of appropriate size and grade to have sufficient collapse and tensional strengths to maintain integrity during well construction and for the life of the well. Well materials will be compatible with injected fluids and formation fluids.

Casing materials to be used include fiberglass-reinforced plastic (FRP), low carbon steel (LCS), and Schedule 80 polyvinyl chloride (PVC). Each of these materials provide certain advantages, and a well may have more than one type of casing; for example, as shown on Figures M-1 and M-2, PVC may be used in the upper part of the borehole above the cement seal and FRP casing may be used in the lower grouted section. PVC is compatible with lixiviant but it will not be used in the grouted sections due to the heat generated during curing. Alternatively, FRP may be used throughout. Alternatively, as shown on Figure M-3, LCS casing may be used above FRP casing; in this case a packer will be used to isolate the lixiviant so that it comes in contact with the FRP section only.

Casing centralizers will be placed every 40 feet along the casing (and screen, if used) length. The casing string will be suspended in the borehole until the annular materials are installed.

2.4 Leak Detection Conductivity Probes

Excelsior does not plan to install leak detection conductivity probes. Instead, temperature logs will meet be run to meet the Part 2 mechanical integrity requirement for wells constructed with PVC and/or FRP materials. The cement bond log will meet the Part 2 mechanical integrity requirement for wells with steel casing.

2.5 Annular Materials Program

Under §146.32 of the federal UIC regulations, Class III wells must be cased and cemented to prevent the migration of fluids into or between USDWs. The cemented interval of each well annulus will be required to pass a mechanical integrity test as defined by the USEPA (Attachment P).

Prior to cementing, suitable mud dispersing chemicals will be circulated to assist in the removal of drilling mud from the annulus and to promote bonding between the casing, cement, and formation. Cement will consist of sulfate-resistant Portland Type V cement that is mixed thoroughly and free of lumps.

During cementing the casing will be filled with fluid of sufficient density to prevent collapse of the casing. The casing annulus of all Class III wells will be grouted from a depth of 40 feet below the bedrock (minimum) to 100 feet above the basin fill/bedrock contact (or static groundwater level, whichever is shallower). The grout will be pumped through a grout pipe inside the casing, which is fitted with a drillable cementing shoe (or float shoe), and raised above the bottom of the borehole. The cementing shoe has a backpressure valve, which prevents grout from backing up into the casing when the grout pipe is removed. The grout is forced around the bottom of the casing and upward in the annular space. The grout pipe is then detached from the cementing shoe and raised to the surface. After the required setting time, the cementing shoe is drilled out and the work on the well continued. The cement grout will be allowed to cure for 24 hours prior to resumption of drilling.

Clean fill will be installed from the top of the cement to 20 feet below the ground surface using a tremie pipe. Then the surface casing will be removed and the annulus from 20 feet to the ground surface will be filled with cement grout.

Wellheads will be protected with vaults, bollards, standpipes, or some combination of these.

3. LOGGING PROCEDURES

3.1 Well Installation Logs

Daily logs and records will be maintained during drilling and well installation activities. Data that will be logged includes drilling/penetration rates, circulation rates and significant variations, testing, mud characteristics, and other operations. Lithologic logs will be maintained describing geologic material encountered during drilling, the depths at which changes in formation occur, and difficulties or unusual conditions encountered. Construction and cementing operations will be documented.

3.2 Geophysical Logging

After the well construction is complete, the well will be logged using the following borehole geophysical methods:

- Gamma
- Sonic (injection wells only)
- Temperature (all wells)
- Caliper
- ABI (Acoustic Borehole Image) or equivalent
- Cement bond logs (only on wells with steel casing) for Part 2 Mechanical Integrity.
- Directional survey

Temperature logs will be run in all wells. This log will meet the requirements for Part 2 mechanical integrity if the casing is constructed of PVC or FRP. Excelsior prefers to use sonic logs rather than density logs to evaluate porosity.

Geophysical logging will not be conducted prior to installing casing.

ATTACHMENT M

CONSTRUCTION DETAILS

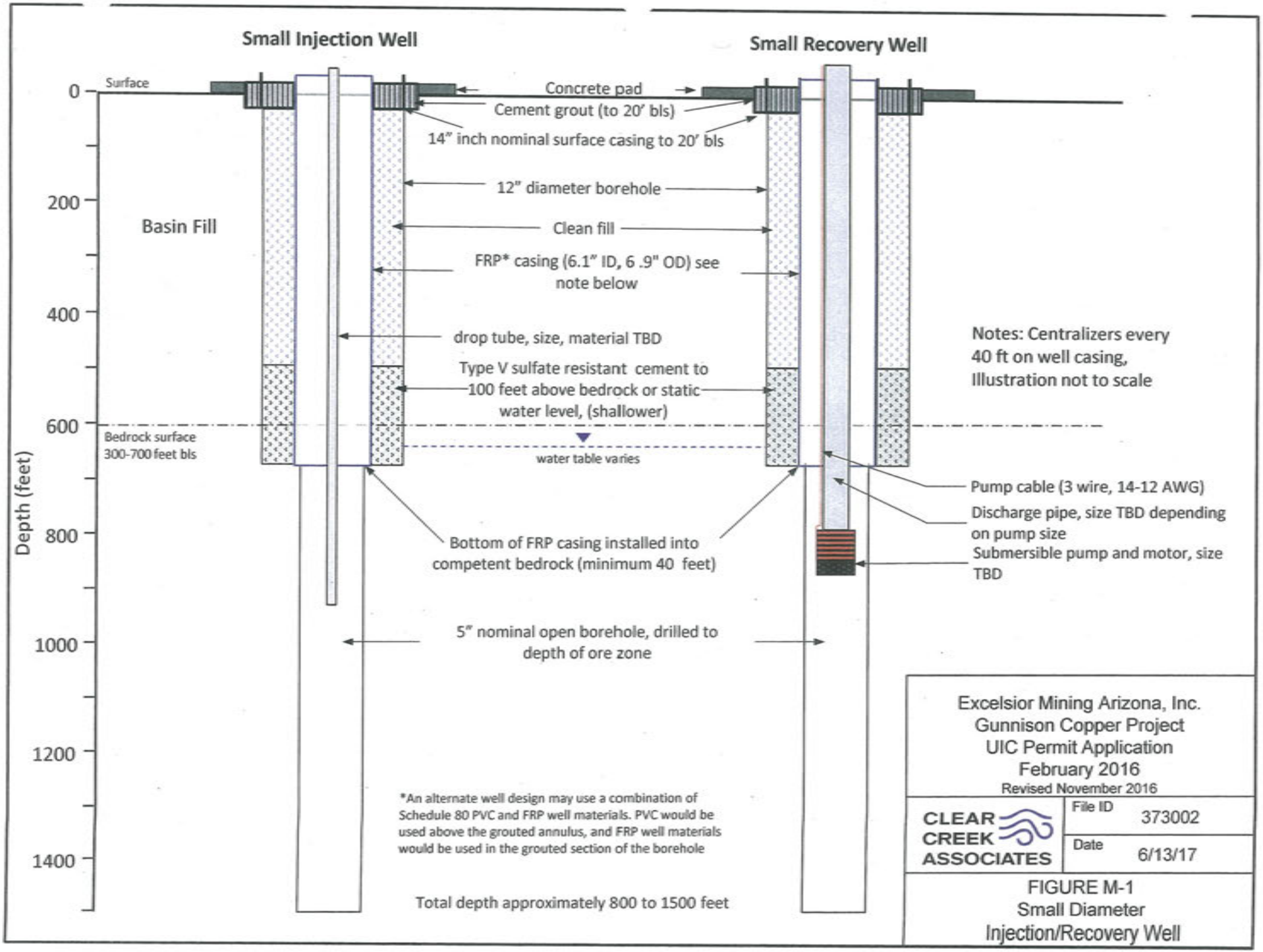
TABLE OF CONTENTS

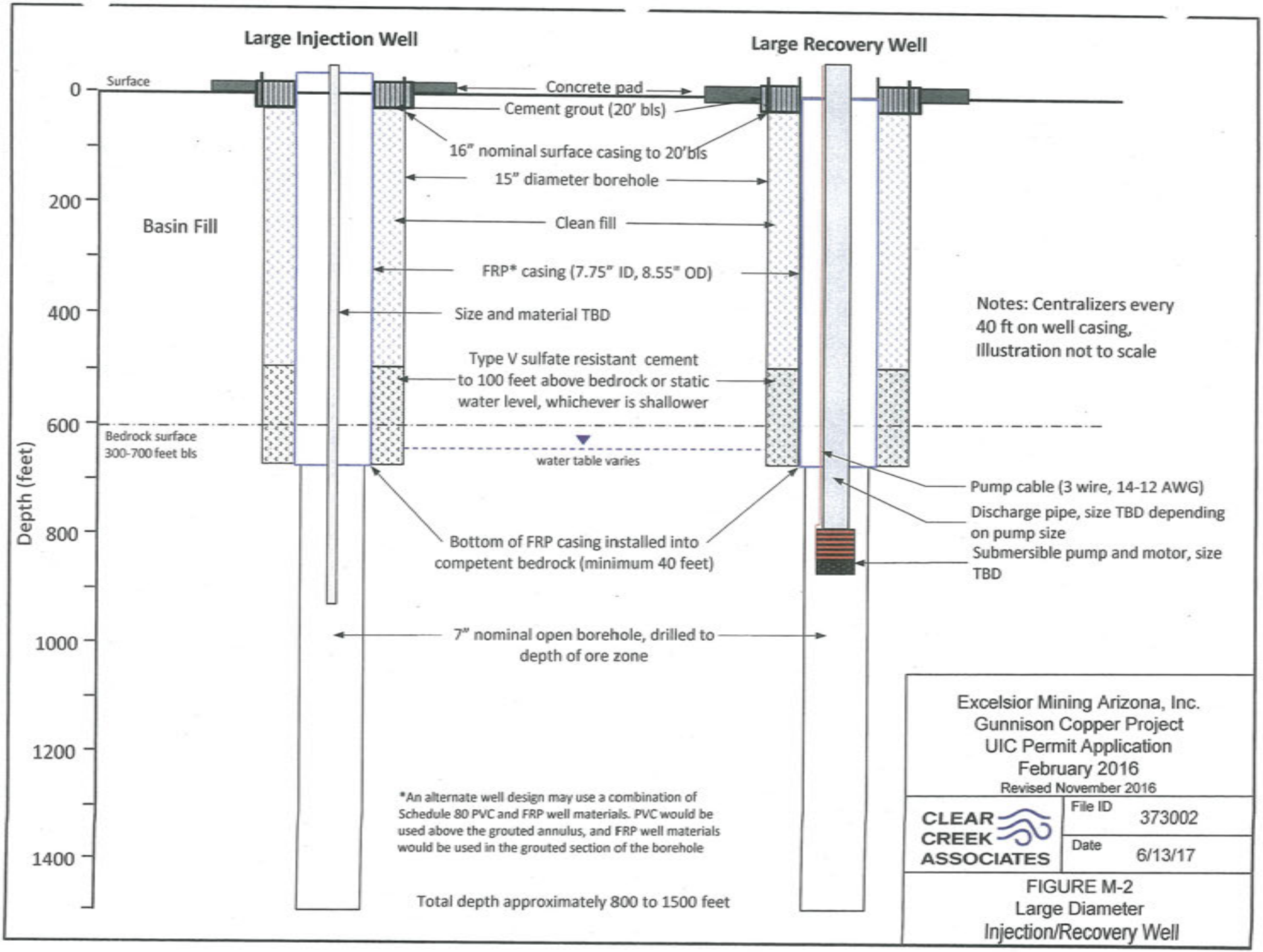
FIGURES

1. CONSTRUCTION DETAILS

This Attachment was prepared in support of Excelsior Mining Arizona, Inc.'s (Excelsior's) Underground Injection Control (UIC) Permit application to the United States Environmental Protection Agency (USEPA). Excelsior is applying for an area Class III UIC permit to install a wellfield for in-situ recovery (ISR) of copper at the Gunnison Copper Project (Project), located in Cochise County, Arizona. This Attachment documents the well construction details of Class III wells to be installed at the Project.

Construction procedures are described in Attachment L.


Small Injection Well
Small Recovery Well
Surface
Concrete pad
Cement grout (to 20' bls)
14" inch nominal surface casing to 20' bls
12" diameter borehole
Clean fill
FRP* casing (6.1" ID, 6 .9" OD) see note below
drop tube, size, material TBD
Type V sulfate resistant cement to 100 feet above bedrock or static water level, (shallower)
water table varies
Basin Fill
Bedrock surface 300-700 feet bls
Bottom of FRP casing installed into competent bedrock (minimum 40 feet)
5" nominal open borehole, drilled to depth of ore zone
Pump cable (3 wire, 14-12 AWG)
Discharge pipe, size TBD depending on pump size
Submersible pump and motor, size TBD
Notes: Centralizers every 40 ft on well casing, Illustration not to scale
Depth (feet)
0
200
400
600
800
1000
1200
1400
*An alternate well design may use a combination of Schedule 80 PVC and FRP well materials. PVC would be used above the grouted annulus, and FRP well materials would be used in the grouted section of the borehole
Total depth approximately 800 to 1500 feet
Excelsior Mining Arizona, Inc.
Gunnison Copper Project
UIC Permit Application
February 2016
Revised November 2016
CLEAR CREEK ASSOCIATES
File ID 373002
Date 6/13/17
FIGURE M-1
Small Diameter
Injection/Recovery Well


Large Injection Well
Large Recovery Well
Surface
Concrete pad
Cement grout (20' bls)
16" nominal surface casing to 20'bls
15" diameter borehole
Clean fill
FRP* casing (7.75" ID, 8.55" OD)
Size and material TBD
Type V sulfate resistant cement to 100 feet above bedrock or static water level, whichever is shallower
Basin Fill
Bedrock surface 300-700 feet bls
water table varies
Bottom of FRP casing installed into competent bedrock (minimum 40 feet)
7" nominal open borehole, drilled to depth of ore zone
Pump cable (3 wire, 14-12 AWG)
Discharge pipe, size TBD depending on pump size
Submersible pump and motor, size TBD
Notes: Centralizers every 40 ft on well casing, Illustration not to scale
Depth (feet)
0
200
400
600
800
1000
1200
1400
*An alternate well design may use a combination of Schedule 80 PVC and FRP well materials. PVC would be used above the grouted annulus, and FRP well materials would be used in the grouted section of the borehole
Total depth approximately 800 to 1500 feet
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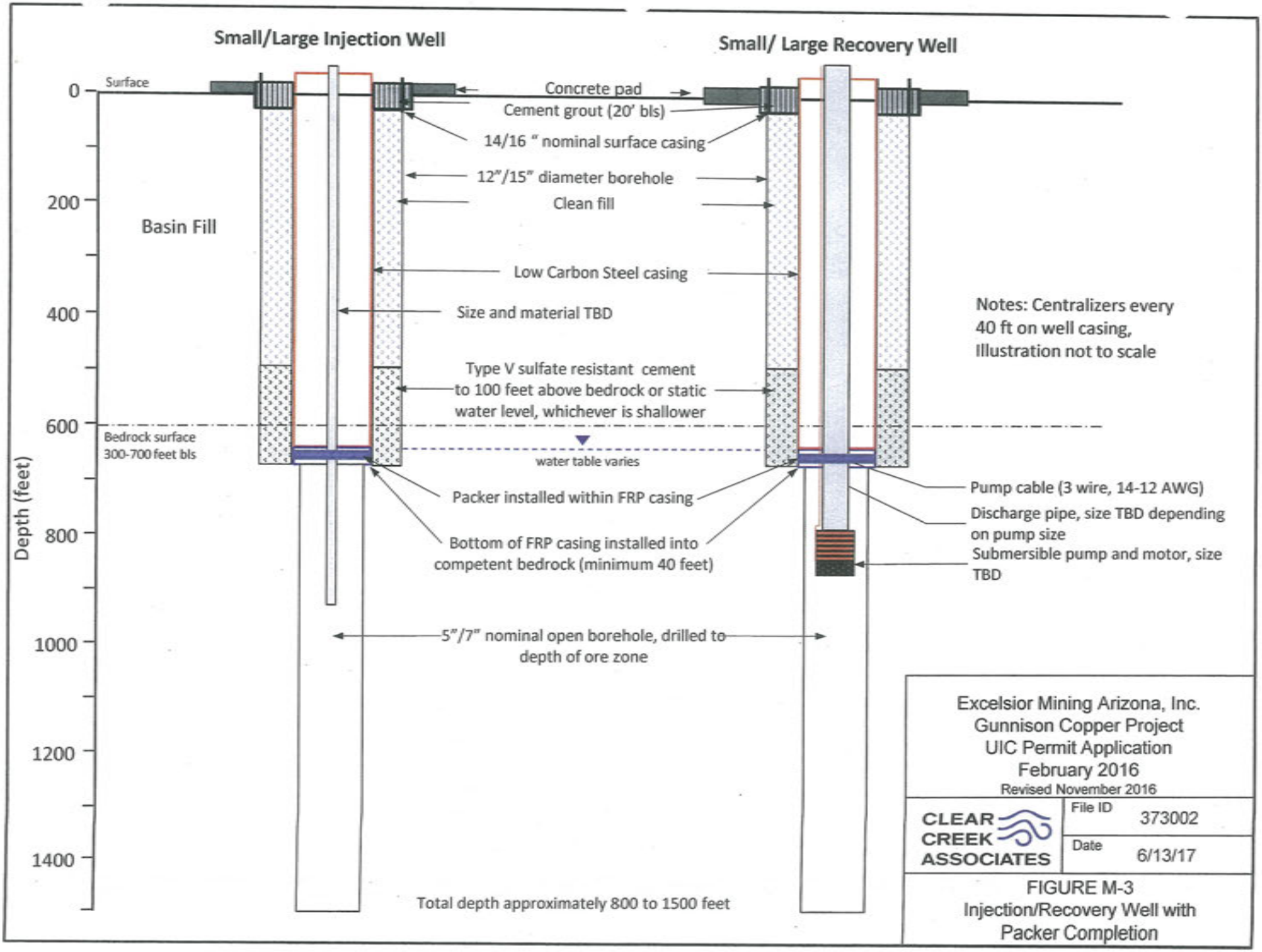
CLEAR CREEK ASSOCIATES
File ID 373002
Date 6/13/17
FIGURE M-2
Large Diameter
Injection/Recovery Well



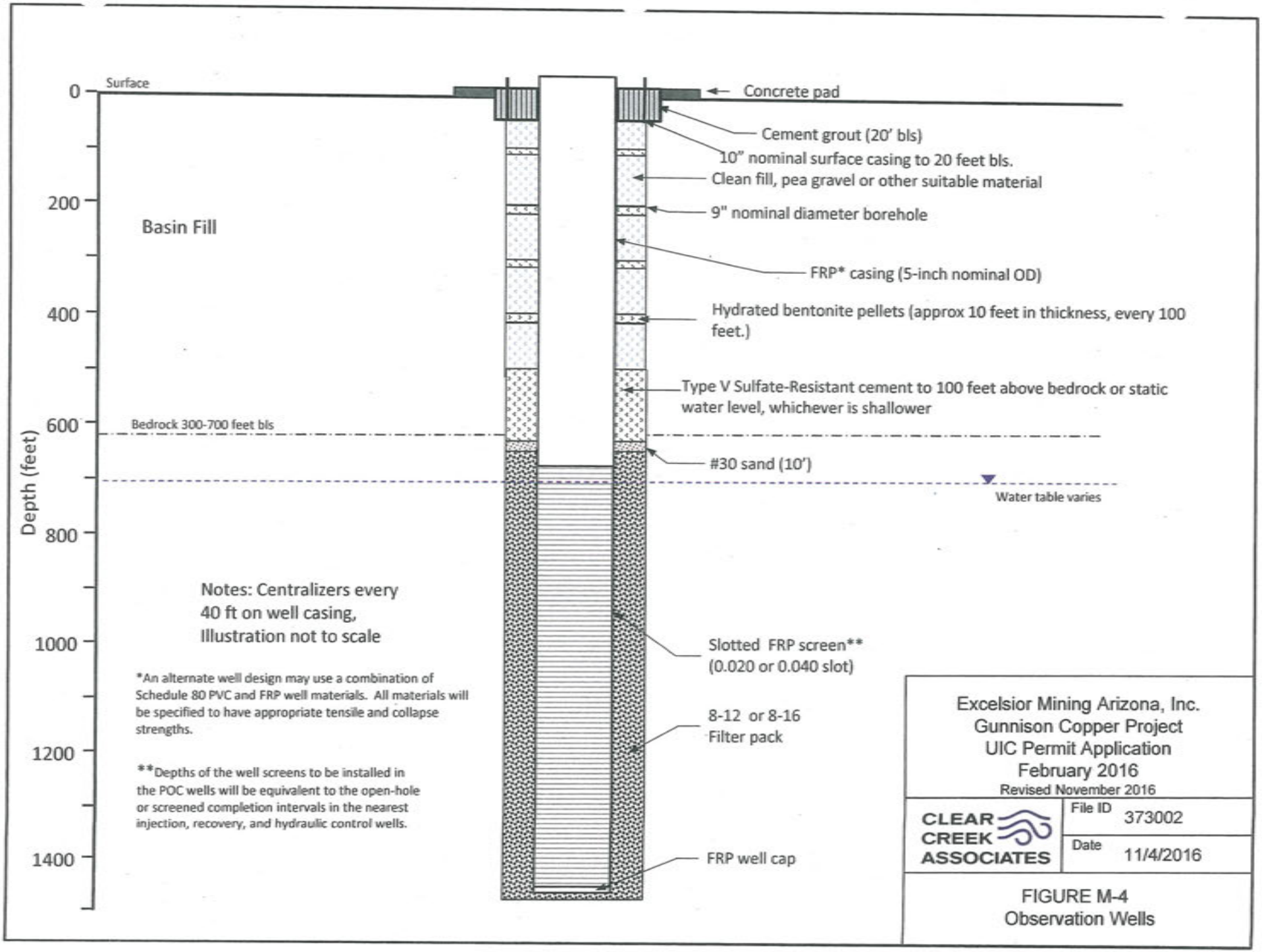
Excelsior Mining Arizona, Inc.
Gunnison Copper Project
UIC Permit Application
February 2016
Revised November 2016

CLEAR CREEK ASSOCIATES

File ID 373002

Date 6/13/17

FIGURE M-3
Injection/Recovery Well with Packer Completion



Excelsior Mining Arizona, Inc.
Gunnison Copper Project
UIC Permit Application
February 2016
Revised November 2016

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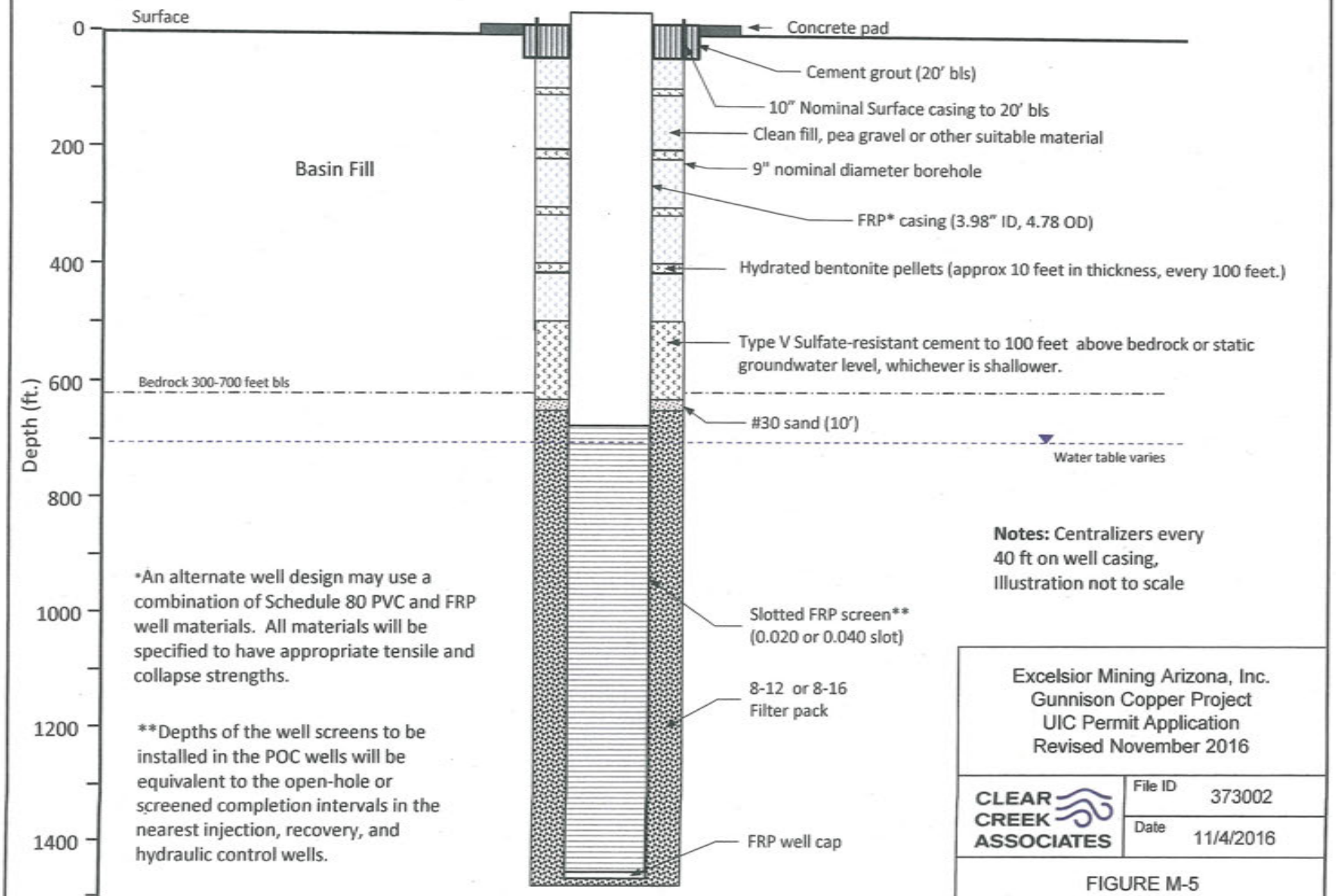
File ID 373002

Date 11/4/2016

FIGURE M-4
Observation Wells



Excelsior Mining Arizona, Inc.
Gunnison Copper Project
UIC Permit Application
Revised November 2016

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File ID 373002

Date 11/4/2016

FIGURE M-5
Wellfield Point of Compliance Wells