

Timothy Welch
Director of Utilities
City of Sunrise, Utilities Department
Utilities Administrative Complex
777 Sawgrass Corporate Parkway
Sunrise, FL 33325

Arcadis U.S., Inc.
1500 Gateway Blvd
Suite 200
Boynton Beach
Florida 33426
Tel 561 697 7000
Fax 561 369 4731
www.arcadis.com

Subject:
City of Sunrise Springtree WTP Injection Well System
IW2 Injection Tubing Installation

WATER

Date:
June 17, 2016

Dear Mr. Welch:

Contact:
Rodney J. Miller

Youngquist Brothers Inc. (YBI) is currently constructing and testing a Class I injection well system at the City of Sunrise, Springtree Water Treatment Plant (WTP). The system includes two Class I injection wells (IW1 and IW2) and a dual-zone monitor well (DZMW1). Excluding above-grade wellhead components, construction and testing of IW1 and DZMW1 are complete. On May 22, 2016, the installation of the innermost injection tubing of IW2 was in progress when an obstruction was encountered prohibiting further installation of the tubing. After removal of the tubing and investigation of the cause and extent of the obstruction, YBI has proposed to modify the tubing and male packer mandrel (attached to the base of the tubing). Further discussion of the obstruction and subsequent investigation and YBI's proposal (with supporting information) are attached.

Phone:
561.719.2422

Email:
Rodney.miller@arcadis.com

Our ref:
06958033.0000

Florida License Numbers

Engineering
7917

Geology
GB564

Surveying
LB7062

The information from YBI has been carefully reviewed to establish our opinion whether the proposed modifications meet the intended purpose and do not diminish the performance, integrity and lifespan of the well.

Performance

Chapter 62-528.415(1), Florida Administrative Code (FAC) requires velocities within the well not to exceed 10 feet per second (fps). Florida Department of Environmental Protection (FDEP) Underground Injection Control (UIC) has interpreted this limitation to apply to velocities within the final casing (not the injection tubing liner) for well designs, such as IW1 and IW2, with a tubing-and-

packer completion with a fluid-filled annulus. IW2 has been designed for an injection capacity of up to 12.4 million gallons per day (MGD). This design capacity is equivalent to an approximate flow of 8,600 gallons per minute (gpm) at an injection velocity in the injection tubing of 10.9 fps and an injection velocity in the final casing of 5.6 fps. YBI's proposal does not include modifications to the inside diameter of the tubing or to the inside diameter of the final casing, and the tubing-and-packer (with a fluid annulus) completion will be maintained. Therefore, we do not anticipate any adverse impacts to design flows, velocities and overall performance of IW2.

Integrity

Class I injection wells are strictly regulated in order to protect underground sources of drinking water, and regular testing of the wells is required to demonstrate that integrity of the system is maintained. FDEP UIC requires testing every five years that demonstrates whether the system has both external and internal integrity. External integrity involves the adequacy of the cement bond between the 26-inch outside diameter (O.D.) steel casing and the rock formation. Considering the final casing has already been cemented in place, the proposed modifications will not impact the external integrity of IW2.

Internal integrity involves the adequacy of the steel final casing, the injection tubing (lining the steel casing) and the positive placement packer assembly sealing the annulus between the casing and the tubing. FDEP UIC considers the primary (most definitive) method to demonstrate internal integrity is through hydrostatic pressure testing of the fluid-filled annulus as defined in Chapter 62-528.300(6)(e), FAC. During testing, the annulus is pressurized to an approved pressure (typically near 150 psi) and monitored for one hour. If the pressure does not deviate by more than 5% (more than 7.5 psi from a starting pressure of 150 psi), the final casing, injection tubing and packer seal is considered to demonstrate internal integrity.

Specifications require the installation of Red Box 1250 tubing which has an internal working pressure rating (with manufacturer's safety factors) of 1,250 pounds per square inch (psi). YBI's proposed modifications will reduce the tubing pressure rating to 700 psi. This should not adversely impact the integrity of IW2 since the rating of 700 psi is 7.5 times greater than the maximum permitted operating pressure that can be inserted on the tubing. For reference, the permitted injection pressure may not exceed two thirds the test pressure applied during annular hydrostatic pressure testing.

Specifications require that YBI install a packer assembly that will provide a proper seal and establish integrity within the annulus. YBI is required to perform an initial pressure test as noted above before the well will be accepted. Stated more clearly, YBI is required to demonstrate internal integrity, as defined by FAC, prior to the City's final acceptance of the well.

Life Expectancy

There are no known industry guidelines that are available to predict the life expectancy of a Class I injection well. Nevertheless, there are regulations and industry standards that, when followed, are anticipated to provide systems that are expected to maintain integrity for more than 10 years. The proposed modifications by YBI are based on their extensive experience and knowledge of Class I injection well construction. Upon YBI demonstrating initial integrity, it is reasonable to assume that the

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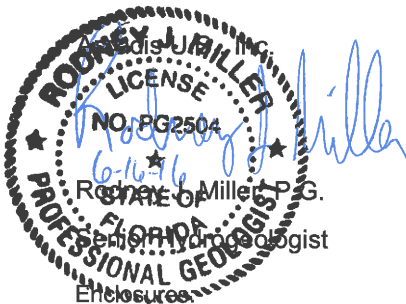
modified packer assembly has properly seated to provide a water-tight seal. Even so, it is prudent and recommended that the City receive additional assurances in the form of an extended ten year warranty. Regulations require that the integrity of an injection well be demonstrated every five years. It is our opinion that YBI's offer of a warranty on the integrity of IW2 should be accompanied by YBI performing additional integrity testing (within 1 year, 5 years, and 10 years of the warranty period) to demonstrate YBI's confidence that the proposed modifications will not result in any adverse impact on the life expectancy of IW2.

Summary

Based on the information presented above and contingent upon initial demonstration of integrity, we believe YBI's proposed modifications are reasonable; and to the best of our knowledge and belief, it is our professional opinion that these modifications will meet design criteria. Additionally, we recognize that these modifications do result in the City receiving and accepting a completed well with unique modifications due to the circumstances encountered during installation of the injection tubing. Therefore, we recommend, and our professional opinion is contingent upon, YBI conducting additional integrity testing, warranting the integrity of IW2 for ten years, and securing the warranty with a bond or other City accepted guaranty.

Please feel free to contact me if you have any questions.

Sincerely,



- Exhibit A: Summary of Obstruction and YBI's Proposed Modifications
- Exhibit B: YBI Proposal
- Exhibit C: FPI Technical Summary of Modified FRP Injection Tubing
- Exhibit D: FPI Attestment of YBI's Ability to Modify Couplings
- Exhibit E: FPI Recommended Tubing Compression Loads
- Exhibit F: YBI Modified Packer Assembly Design
- Exhibit G: Starrett Caliper Gauge for Field Verification