MWA personnel. Approximately 6.7 casing volumes of water was removed from the well by bailing and pumping prior to collecting the initial groundwater sample. Chain-of-custody documentation was enclosed with the sample shipment and groundwater samples were analyzed by the MWA laboratory. Results of groundwater sample analysis have been summarized in Table 5 and the laboratory report is included in Appendix G. A data verification was conducted and all reported data is valid.

Dual tube airlifting to attempt removal of the sediment remaining in the bottom of the well was conducted on March 14 to 16, 2022. To maintain adequate submergence, municipal potable water was added from the adjacent hydrant as needed. It was necessary to add a total of approximately 136,150 gallons of municipal water to maintain circulation. After approximately 9½ hours of airlifting and removal of 1,725 gallons of water, approximately 7 feet of sediment remained at the bottom of the well.

2.6 SITE CLEANUP, WELL SURVEY, AND WELL COMPLETION REPORT

After well installation and development the Site was cleaned up and left in restored condition. Drill cuttings were spread out over land surface, without disturbing Joshua trees that occur on the property. Litter and other waste were removed from the drill site. MWA conducted a site walk with H+A and ABC staff and approved the restored site conditions.

Following well installation and surface completion, a survey of well locations and elevations was conducted by MWA. The survey was conducted on March 23, 2022. The MWA Well Canvassing Sheet for ORMW1 is provided in Appendix H.

A Well Completion Report for each well was submitted to the California Department of Water Resources on April 4, 2022 (Appendix I).

OESTE MONITORING WELL CLUSTER
WELL CONSTRUCTION REPORT
MOJAVE WATER AGENCY
PINON HILLS, CALIFORNIA

1.0 INTRODUCTION

This Oeste Monitoring Well Construction Report has been prepared by Hargis + Associates, Inc. (H+A) on behalf of the Mojave Water Agency (MWA), for the monitoring well cluster located on parcel APN 309908101 at the west end of Cayucos Drive, Piñon Hills, California (the Site) (Figure 1). Activities described in this report were conducted in accordance with the MWA approved scope of services for monitoring well construction management (H+A, 2021).

The MWA parcel of land adjacent to the California Aqueduct near Phelan, California is intended to be used as a future recharge basin site to meet water delivery obligations to the Oeste Subarea. Existing hydrogeologic information in the area is sparse, and the Oeste monitoring well cluster was installed to fill in data gaps to aid in assessing the feasibility of the proposed aquifer recharge activities; measure and track recharge activities; and provide a long-term monitoring point for the Oeste Subarea. The cluster includes a regional water table monitoring well (ORMW1) and a potential perched zone monitoring well (ORMWP). The well cluster provides valuable data related to subsurface lithologic conditions, groundwater levels, and groundwater quality.

H+A was responsible for providing construction management during the drilling and construction of the wells to ensure that drilling-related activities were conducted in accordance with Technical Specifications specified in the driller contract documents (MWA, 2021). MWA contracted directly with the drilling contractor, ABC Liovin Drilling (ABC).

2.0 CONSTRUCTION ACTIVITIES

The following sections describe the general construction activities by task. The Technical Specifications provide a general description of well drilling, well construction, and well development procedures. This report describes the preparation, drilling, installation, development, and Site clean-up for the monitoring wells.

2.1 PERMITTING AND UTILITY CLEARANCE

Permitting requirements included obtaining County of San Bernardino well construction permits. Permit applications were prepared and submitted by ABC, with review by H+A and MWA. Approved well permits are provided in Appendix A.

Prior to mobilization, H+A conducted a Site visit with MWA and ABC to review rig and drilling footprints and well locations which were cleared for underground utilities by Underground Service Alert. The two well locations located at the northeast corner of the Site were designated with a separation of approximately 33 feet between wells (Figure 2). Well locations were cleared down to approximately 6 to 8 feet below ground surface (bgs) using air-knife excavation.

2.2 BOREHOLE DRILLING

The following sections summarize details of borehole drilling. Monitoring well ORMWP was drilled during the period December 20, 2021 through January 3, 2022. Monitoring well ORMW1 was drilled during the period January 31, 2022 through February 8, 2022.

2.2.1 Drilling of ORMWP

The borehole for monitoring well ORMWP was advanced using sonic drilling methods. Temporary steel casing was driven into the formation using a telescoping approach, with 10-inch diameter casing to 100 feet bgs, 8-inch diameter casing to 320 feet bgs, 6-inch diameter casing to 375 feet bgs, and 4-inch diameter casing to 400 feet bgs (Table 1). The sonic well borehole was drilled using a Terrasonic 600 drill rig.

Terrasonic 600 drill rig

The ORMWP borehole was advanced to a total depth of 400 feet bgs. From the recovered core, which could be as large as seven inches in diameter in the uppermost interval, a narrower core was subsampled and saved to standard core boxes for lithologic description and archiving. Lithologic logging and soil sampling were conducted during borehole drilling as described in Section 2.2.3.

2.2.2 Drilling of ORMW1

The borehole for ORMW1 was advanced using the air rotary casing hammer (ARCH) drilling method. Temporary steel casing is driven into the formation using a hydraulic hammer, with a standard tricone bit of similar diameter drilling just ahead of the casing. Compressed air is used as the circulating fluid, thus no water is added during the drilling process. The temporary casing was advanced using a telescoping approach, with 11¾-inch diameter casing to 240 feet bgs and 10-inch diameter casing to the total depth of 660 feet bgs (Table 1). The ORMW1 borehole was drilled using a Speedstar 50K rotary drill rig configured for ARCH.

Speedstar 50K rotary drill rig configured for ARCH

The well borehole was advanced to the total depth of 660 feet bgs. Drill cutting samples were collected for lithologic description at 5-foot intervals using a sieve-type catcher placed below the cyclone where the air stream with drill cuttings discharges into a hopper. Undisturbed soil core samples were collected from predetermined intervals using a modified California split-spoon sampler driven by a standard 140-pound hammer. Lithologic logging and soil sampling were conducted during borehole drilling as described in Section 2.2.3.

2.2.3 Lithologic Logging and Soil Sampling

Lithologic logging was performed to define the lithology of geologic materials and to characterize subsurface geologic and hydrogeologic conditions. Lithologic logs were compiled based on the description of continuous core samples obtained during sonic drilling of monitoring well ORMWP and on description of drill cutting samples recovered at land surface during ARCH drilling of monitoring well ORMW1.

Soil type was characterized using the Unified Soil Classification System (American Society for Testing and Materials [ASTM], 2009). Soil color was described using Munsell Soil Color Charts (Munsell Soil Color Charts, 1992). Grain size was estimated using ASTM standards (ASTM, 2009). Lithologic logs are included in Appendix B.

Subsamples of continuous core obtained during drilling of ORMWP were submitted to an environmental laboratory for a laboratory leaching test using Synthetic Precipitation Leaching Procedure (SPLP). Sample intervals were selected to target fine grained zones with the potential for mineralogy that may result in leaching of constituents that may negatively affect groundwater quality. The test used synthetic water with chemical and physical properties similar to the State Project water that will be used for future recharge. Results of leachate sampling have been summarized (Tables 2 and 3) and laboratory reports are included in Appendix C. A data verification was conducted and all reported data is valid.

Undisturbed soil samples obtained during drilling of ORMW1 were submitted to a geotechnical laboratory for analysis of grain size distribution, effective porosity, dry bulk density, vertical hydraulic conductivity, and unsaturated zone soil retention curves. Sample intervals were selected to represent a range of observed lithology. Soil physical properties are summarized in Table 4. Geotechnical laboratory reports are provided in Appendix D.

2.3 WELL CONSTRUCTION

Following drilling of each borehole, H+A and MWA determined the final well design for ORMWP and ORMW1 based on lithology and apparent depth to water encountered during drilling. Final as-built monitoring well construction details are provided in Table 1 and Figures 3 and 4.

2.3.1 Monitoring Well ORMWP

Construction of well ORMWP was completed on January 5, 2022. ORMWP was installed in a dry borehole, and is intended to act as a monitoring well screened in soil that may become saturated above a potential perching layer during future recharge events. Well construction details for ORMWP are summarized in Table 1 and Figure 3.

The bottom seal (portion of the borehole below the target depth for well construction) was backfilled with 50 percent No. 8 granular bentonite / 50 percent Monterey No. 3 sand by weight. The bentonite/sand seal was emplaced by pouring materials into the dry borehole from the surface, utilizing the temporary casing as a tremie pipe. The bentonite/sand seal was emplaced into the borehole from the bottom up, withdrawing the temporary casing as the borehole was backfilled.

Nominal 2-inch diameter Schedule 80 polyvinyl chloride (PVC) well screen (0.020-inch factory slotted) and nominal 2-inch diameter Schedule 80 PVC blank well casing was used to construct the monitoring well. Centralizers were installed at the top and bottom of the screen interval and at approximate 40-foot intervals along the blank well casing.

A filter pack consisting of Monterey No. 3 sand was emplaced dry in the annulus between the well screen and the borehole wall. A filter pack transition seal (intermediate seal) consisting of 50 percent No. 8 granular bentonite / 50 percent Monterey No. 3 sand by weight was emplaced into the annulus above the filter pack using the temporary casing as a tremie pipe, as described above. The temporary casing was gradually withdrawn as the bentonite/sand level rose during emplacement. The sanitary seal consists of neat cement grout containing 5 percent bentonite emplaced from the top of the intermediate seal to 2 feet bgs. From approximately 2 feet bgs to land surface, the annulus was filled with concrete in order to set the above-ground monument vault (see Section 2.3.3).

2.3.2 Monitoring Well ORMW1

Construction of monitoring well ORMW1 was completed on February 14, 2022. Well construction details for ORMW1 are summarized in Table 1 and Figure 4. Prior to beginning well construction activities, the bottom of the borehole was tagged at 552 feet bgs, indicating slough filled the bottom 8 feet of the borehole.

Nominal 4-inch diameter Schedule 80 PVC well screen (0.020-inch factory slotted) and nominal 4-inch diameter Schedule 80 PVC blank well casing was used to construct the well. Centralizers were installed at the top, center and bottom of the screen interval and at approximate 40-foot intervals along the blank well casing.

A filter pack consisting of Monterey No. 3 sand was emplaced in the annulus between the well screen and the borehole wall, using the temporary casing as a tremie pipe. A filter pack transition seal (intermediate seal) consisting of 50 percent medium bentonite chips / 50 percent 8 x 16 No. 12 mesh sand by volume was emplaced into the annulus above the filter pack using the temporary casing as a tremie pipe, as described above. The temporary casing was gradually withdrawn as the bentonite/sand level rose during emplacement. The sanitary seal consists of neat cement grout containing 5 percent bentonite was emplaced from the top of the intermediate

seal to 3 feet bgs. From approximately 3 feet bgs to land surface, the annulus was filled with concrete in order to set the above-ground monument vault (Section 2.3.3).

2.3.3 Surface Completion

Monitoring wells were completed with above-ground monument-type well vaults. Well vaults are constructed of steel tubing set in concrete slightly above the surrounding land surface (Figures 3 and 4). Well vaults are surrounded by steel bollards set in concrete. The monument vault and bollards are painted bright yellow for visibility.

2.4 GEOPHYSICAL LOGGING

Following construction of ORMW1, geophysical logging was conducted using downhole wireline logging tools within the PVC well casing and screen. Geophysical logging was performed on February 15, 2022, by Pacific Surveys, Claremont, California. Geophysical logs are provided in Appendix E.

The following logs were run in the borehole:

- Gamma Ray; and
- Electromagnetic Induction (Dual Induction)

Geophysical logs were used to generally confirm subsurface geology based on samples collected during ARCH drilling operations. The dual induction log was also collected to assess the moisture condition of the formation surrounding the borehole, to allow comparison of its present condition with changes in soil moisture following initiation of future recharge events.

2.5 WELL DEVELOPMENT AND GROUNDWATER SAMPLING

Well development was not conducted at ORMWP because the well was dry at the time of installation.

Initial development of ORMW1 was performed immediately following placement of the filter pack and consisted of gentle swabbing to settle the filter pack. No settling occurred; thus no additional filter pack sand was added.

Final development of monitoring well ORMW1 was performed during the period March 1 through March 16, 2022. Monitoring well development details have been provided (Table 5; Appendix F). Development methods for monitoring well ORMW1 incorporated swabbing, bailing, pumping and dual-tube airlifting. Water generated during well development was discharged to the land surface on-property.

Bailing of monitoring well ORMW1 was conducted to remove approximately 10 feet of sediment from the bottom of the screen interval. Bailing proved to be minimally effective despite attempts using several bailer designs. While approximately 2.9 feet of sediment and 38 gallons of water was bailed from the bottom of the well, additional sediment entered the well during the process, resulting in approximately 20 feet of sediment at the bottom of the well. After consultation with ABC and MWA, it was decided to discontinue bailing and attempt to remove the remaining sediment using dual-tube air lifting. Due to airline submergence limitations, it was not anticipated that effective development via dual-tube airlifting would be possible without increasing the level of submergence in the well by adding municipal potable water from the adjacent hydrant. Therefore, pumping development and subsequent collection of the initial groundwater sample was conducted prior to resuming removal of the sediment via air lifting/addition of hydrant water to ensure the sample is representative of groundwater conditions and not impacted by the addition of hydrant water to the well.

During pumping development, the well was pumped at a rate of approximately two gallons per minute, and approximately 364 gallons of water was removed by pumping. Turbidity decreased throughout pumping development, with a final turbidity of 3.7 nephelometric turbidity units indicating that the well was sufficiently developed (Appendix F). At the end of pumping development on March 2, 2022, the initial groundwater sample was collected from ORMW1 by

MWA personnel. Approximately 6.7 casing volumes of water was removed from the well by bailing and pumping prior to collecting the initial groundwater sample. Chain-of-custody documentation was enclosed with the sample shipment and groundwater samples were analyzed by the MWA laboratory. Results of groundwater sample analysis have been summarized in Table 5 and the laboratory report is included in Appendix G. A data verification was conducted and all reported data is valid.

Dual tube airlifting to attempt removal of the sediment remaining in the bottom of the well was conducted on March 14 to 16, 2022. To maintain adequate submergence, municipal potable water was added from the adjacent hydrant as needed. It was necessary to add a total of approximately 136,150 gallons of municipal water to maintain circulation. After approximately 9½ hours of airlifting and removal of 1,725 gallons of water, approximately 7 feet of sediment remained at the bottom of the well.

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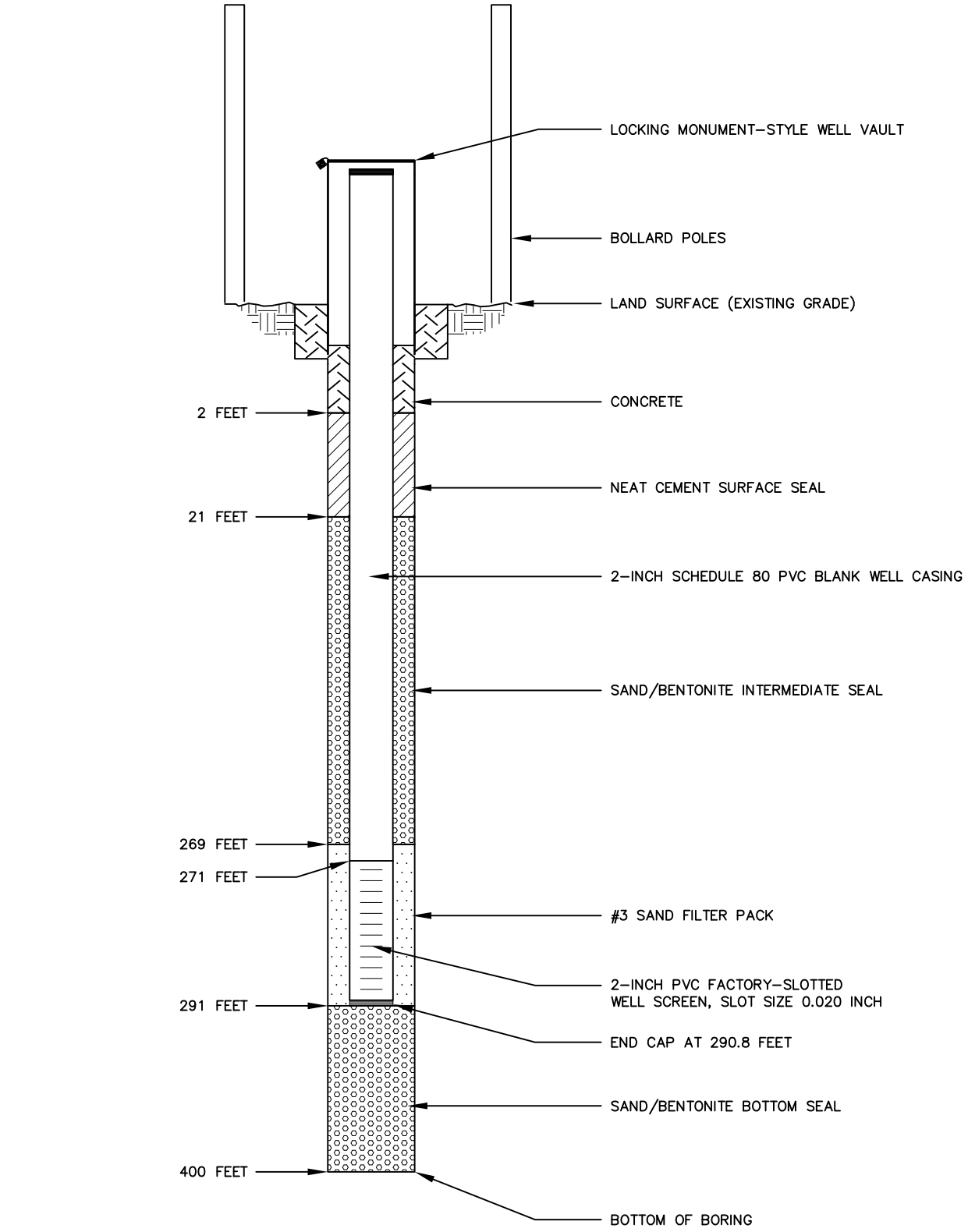
A Well Completion Report for each well was submitted to the California Department of Water Resources on April 4, 2022 (Appendix I).

AS-BUILT



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HARGIS+ASSOCIATES, INC.
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FIGURE 3.
SCHEMATIC CONSTRUCTION DIAGRAM, MONITORING WELL ORMWP

AS-BUILT

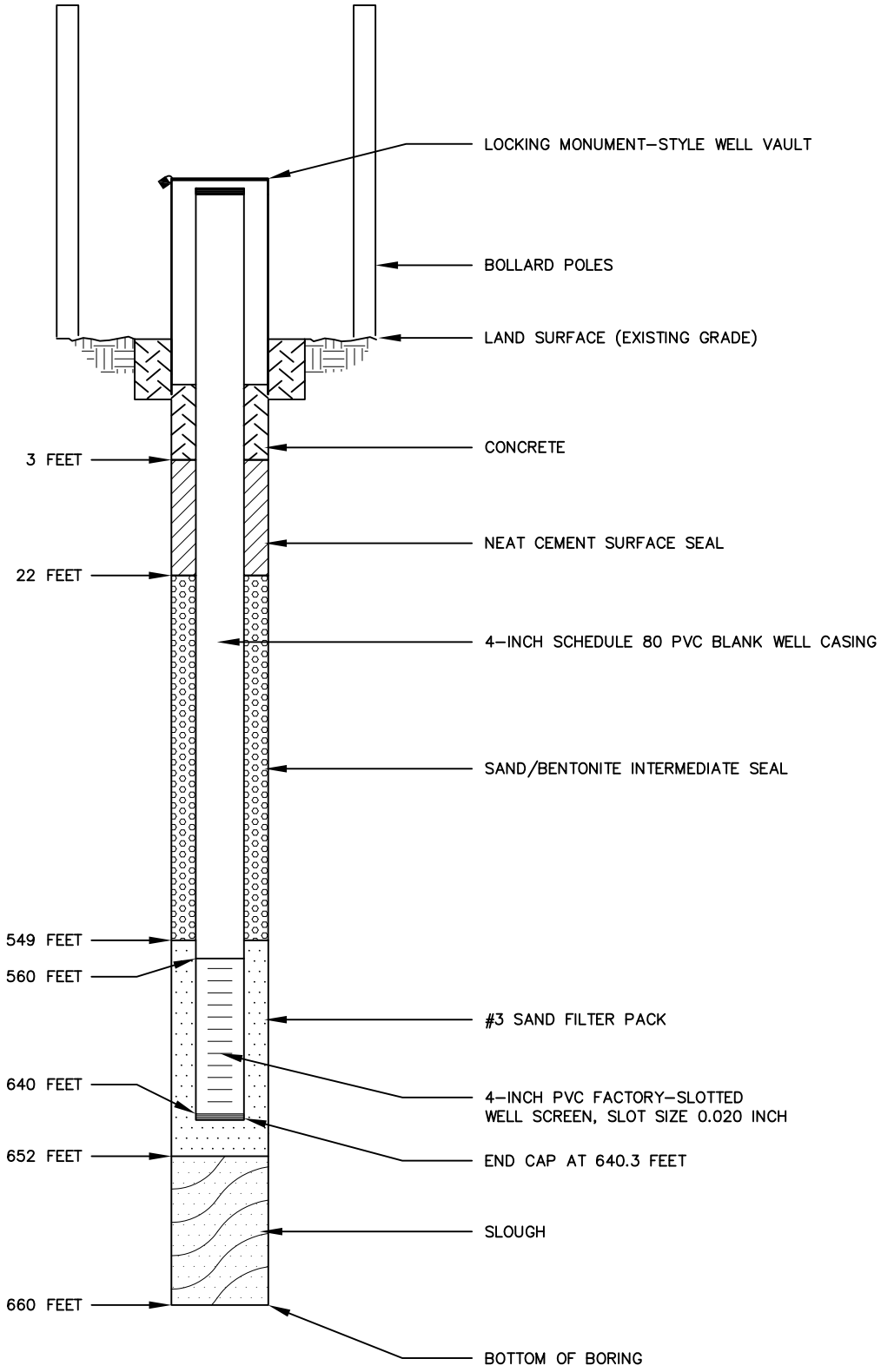

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FIGURE 4.
SCHEMATIC CONSTRUCTION DIAGRAM, MONITORING WELL ORMW1