FREEPORT-McMoRan COPPER & GOLD

Sierrita Operations
Environment, Land & Water Department
6200 West Duval Mine Road
PO Box 527
Green Valley, Arizona 85622-0527

December 31, 2013

Via UPS # 1Z 867 7E4 23 1001 498 4

Ms. Marcia Colquitt
Arizona Department of Environmental Quality
Water Quality Compliance Section
1110 West Washington Street
Phoenix, Arizona 85007-2935

Re: Mitigation Order on Consent Docket No. P-50-06
October 1st through December 31st, 2013 Status Report

Dear Ms. Colquitt:

In accordance with Section V.A. of the Mitigation Order on Consent, Docket No. P-50-06, Freeport-McMoRan Sierrita Inc. (Sierrita) submits the Status Report covering the period from October 1st through December 31st, 2013.

Since the last Status Report was submitted, the following actions have been taken under Section III of the Mitigation Order:

- Fourth quarter 2013 groundwater monitoring was completed.
- The fourth Community Advisory Group meeting of the year was held on December 10, 2013.
- The updated Mitigation Plan was submitted on December 20, 2013. The post implementation monitoring plan was submitted as a section in the Mitigation Plan.
- The technical and economic feasibility study of the new tailing impoundment is still in progress and not expected to be concluded in the near term.
- Construction of the sulfate mitigation action well field was completed. As discussed in the Extraction Well System Start-up Schedule letter date December 17, 2013, the system was started on December 17, 2013 and was operated through December 20, 2013 before it was temporarily shut down.
- The Operation and Maintenance manual that was submitted on June 30, 2011 was updated to include PS, MC and FFS wells. The updated plan titled "Sulfate Mitigation Action Well Field Operation and Maintenance Plan" is included with this report.

The following activities are anticipated to be completed during the next quarter:

- Restart the Sulfate Mitigation Action well field on January 6, 2013.
- Conduct quarterly groundwater monitoring according to the revised groundwater monitoring schedule.
- Hold the first CAG meeting of 2014.
- Submit the Semiannual groundwater monitoring report.

Please do not hesitate to contact me at (520) 393-2252 or Martha Mottley at (520) 393-2696 if you have any questions regarding this submittal.

Sincerely,

Kanyembo Katapa, P.E.
Environmental Engineer
Freeport-McMoRan Sierrita Inc.

KK/ms
20131231_001

xc: David Haag, Arizona Department of Environmental Quality
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Jim Norris, Clear Creek Associates

FREEPORT-MCMORAN SIERRITA INC.
SULFATE MITIGATION ACTION WELL FIELD
OPERATION AND MAINTENANCE PLAN

BasinWells
ASSOCIATES PLLC

December 31, 2013

FREEPORT-MCMORAN SIERRITA INC.

SULFATE MITIGATION ACTION WELL FIELD OPERATION AND MAINTENANCE PLAN

Prepared for

Freeport-McMoRan Sierrita, Arizona

December 31, 2013

BASINWELLS ASSOCIATES PLLC PROJECT NO. 13-021

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TABLE OF CONTENTS

LIST OF TABLES IV

LIST OF FIGURES IV

LIST OF ACRONYMS IV

1. INTRODUCTION 1

1.1 LOCATION 2

1.2 PURPOSE 2

1.3 ORGANIZATION OF SIERRITA WITH RESPECT TO WELL FIELD OPERATION 3

2.0 DESCRIPTION 6

2.1 WELL INSTALLATION AND CONSTRUCTION 6

2.2 WELL YIELD AND GENERAL HYDROGEOLOGY 6

2.3 EXISTING INTERCEPTOR WELLS PUMP EQUIPMENT 7

2.4 EXISTING INTERCEPTOR WELLS INSTRUMENTATION AND MONITORING EQUIPMENT 7

2.5 PS, MC, AND FFS WELL PUMP EQUIPMENT 8

2.6 PS, MC, AND FFS WELL INSTRUMENTATION AND MONITORING EQUIPMENT 8

3.0 MAINTENANCE MONITORING 11

3.1 MONITORING REQUIREMENTS 11

3.1.1 PUMPING EQUIPMENT EFFICIENCY 11

3.2 MONITORING RESPONSIBILITIES 12

3.2.1 ENVIRONMENT, LAND AND WATER DEPARTMENT RESPONSIBILITIES 12

3.2.2 SIERRITA WATER COMPANY RESPONSIBILITIES 15

3.2.3 WELL FIELD DATA MANAGEMENT 16

3.3 WELL PERFORMANCE EVALUATIONS 16

4.0 MAINTENANCE REQUIREMENTS 19

4.1 PUMP EQUIPMENT MAINTENANCE....19
4.2 WELL CLEANING AND REDEVELOPMENT....20
4.3 WELL REHABILITATION....21
4.4 WELL REPLACEMENT....21
5.0 CORRECTIVE ACTION GUIDE....23
5.1 DECLINING WELL PERFORMANCE....23
5.2 PUMPING EQUIPMENT AND TRANSMISSION PIPELINE DETERIORATION OR FAILURE....23
APPENDIX A....25
Sulfate Mitigation Action Well Field Plots (Version Date: December 15, 2013)....25
APPENDIX B....65
Sample Field Forms....65
APPENDIX C....66
Pump Performance Evaluation Review Forms....66
APPENDIX D....67
Procedures for Evaluation of Well Pump Performance....67

LIST OF TABLES

TABLE 1. SULFATE MITIGATION WELL FIELD CONSTRUCTION INFORMATION 5

TABLE 2. SULFATE MITIGATION WELL FIELD PUMP EQUIPMENT INFORMATION 10

TABLE 3. MONITORING RESPONSIBILITIES 18

LIST OF FIGURES

Figure 1. Sulfate Mitigation Well Field 4

LIST OF ACRONYMS

ADWR	Arizona Department of Water Resources
AWWA	American Water Works Association
BasinWells	BasinWells Associates, PLLC
bls	below land surface
ELW	Environment, Land and Water Department
FFS	Focused Feasibility Study
gpm	gallons per minute
HSLA	high-strength low-alloy
IW	Interceptor Well
LCS	low-carbon steel
MC	Mass Capture
O&M	Operation and Maintenance
O&M Plan	Interceptor Well Field Operation and Maintenance Plan
PRV	pressure-release valve
PS	Plume Stabilization
QA/QC	quality assurance/quality control
Sierrita	Freeport-McMoRan Sierrita Inc.
Well Field	Interceptor Well Field

SULFATE MITIGATION ACTION WELL FIELD OPERATION AND MAINTENANCE PLAN

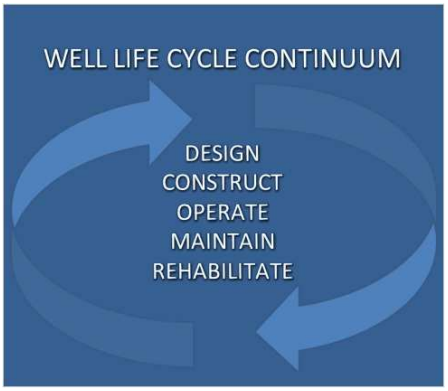
1. INTRODUCTION

This Sulfate Mitigation Action Well Field (Well Field) Operation and Maintenance Plan (O&M Plan) identifies the O&M activities for the groundwater extraction system implemented under the *Mitigation Plan for Sulfate with Respect to Drinking Water Supplies in the Vicinity of the Freeport-McMoRan Sierrita Inc. Tailing Impoundment* (Mitigation Plan) prepared by Clear Creek Associates in 2013. (The FFS, PS, and MC Well Field Operations and Maintenance Manual, prepared by WestLand Resources contains additional detail for the equipment installed at these wells. This includes figures depicting a typical well layout, and equipment manuals provided by the construction contractor. This document also provides information on the electrical and control equipment, including operational set points used in the control software.)

The Well Field includes the groundwater extraction wells, pumping facilities, and pipelines installed as mitigation facilities to extract, convey and manage sulfate-bearing water pursuant to the Mitigation Plan. The principal goal of the operation of the Well Field is to achieve the mitigation action objective identified in the Mitigation Plan.

The Mitigation Plan identifies groundwater pumping specifications for the wells of the Well Field. The adequacy of the groundwater pumping for meeting the mitigation action objective will be evaluated periodically by mitigation performance reviews specified by the Mitigation Plan. The mitigation performance reviews will evaluate groundwater monitoring and well field operating data to assess the efficacy of the mitigation action. Groundwater pumping rates may be modified based on the findings of the performance review. The Well Field will implement the pumping specifications of the Mitigation Plan and subsequent performance reviews to the degree practicable.

This O&M Plan was developed within the framework of the Well Life Cycle Continuum as presented by Smith and Comeskey in *Sustainable Wells, Maintenance, Problem Prevention and Rehabilitation* (2010).



1.1 LOCATION

The Well Field consists of two major parts; the Interceptor Well Field and the Mitigation Well Field. The Interceptor Well Field currently consists of 24 active interceptor wells (IWs). A new Interceptor Well is planned, and is currently in the design phase to be constructed in 2014. The Mitigation Well Field consists of four plume stabilization (PS) wells, four mass capture (MC) wells, and six focused feasibility study (FFS) wells. The PS, MC, and FFS wells were installed between 2011 and 2013, with full operation scheduled for late 2013.

Water from the Interceptor Well Field is pumped through a series of booster stations to the Mill Reservoir. The Mitigation Well Field groundwater is likewise pumped through a separate series of booster stations for delivery to the Mill Reservoir. Both systems are combined with water from other Sierrita sources at several locations along the flow path. The mixed water in the Mill Reservoir is then used as process water for mine operations.

The locations of the wells of the Well Field are shown on Figure 1. Table 1 tabulates well information, including cadastral legal locations, well construction details, drill date, and well age.

1.2 PURPOSE

This O&M Plan was developed to assist Sierrita in the operation and maintenance of the Well Field to ensure that the mitigation action objective specified in the Mitigation Plan is accomplished over time. The O&M Plan presents the operational parameters that require routine monitoring and analysis to aid in the identification and scheduling of required pump equipment maintenance, well cleaning and redevelopment, and well rehabilitation activities to optimize Well Field performance. The criteria for well replacement are also presented.

This O&M Plan will also serve as the basis for the training of new operators and to provide continuity during changes in assigned personnel. The principal goals of the Plan are to provide:

- Guidance for the operation of the Well Field;
- Instructions for the monitoring of Well Field operational parameters as well as criteria for planning maintenance reviews for specific wells; and
- A basis for long-term budgetary planning for Well Field operation, maintenance, and monitoring activities.

The O&M Plan guidance includes a detailed list of periodic tasks to be implemented by Sierrita. This document and the guidance herein is intended as a living document, and the nature and frequency of the tasks may be changed over time based upon experience gained with operation of the system and the principle of adaptive management. The guidance in this document is not intended to create a legally enforceable obligation to perform each individual task. Instead, this O&M Plan is intended to spell out

the procedures which, as a whole, are expected to result in satisfactory operation of the Well Field that will accomplish the mitigation action objective.

The O&M Plan will be reviewed at least annually and updated periodically as new information about the Well Field is acquired. In addition, as future changes or additions to the Well Field occur, additional O&M issues not covered in the O&M Plan may become apparent, and additional revisions to the Plan may be needed.

1.3 ORGANIZATION OF SIERRITA WITH RESPECT TO WELL FIELD OPERATION

The current organizational structure of Sierrita divides the responsibilities and labor for the O&M activities of the Well Field into two major groups: the Environment, Land and Water Department (ELW) and the Sierrita Water Company. ELW tasks center on regular data acquisition, the monitoring of trends, and notification regarding identified issues, with a focus on yield goals for the system and individual wells. Sierrita Water Company tasks are mainly concerned with the maintenance of the Well Field materials and equipment. Its main goals are to ensure that the system is running efficiently, remedy any equipment malfunctions or failures, and respond to trends and identified issues with the required troubleshooting, repair, or rehabilitation of the wells. The Sierrita Water Company is also tasked with keeping the well pumps operating at the maximum practical availability with direction of ELW.

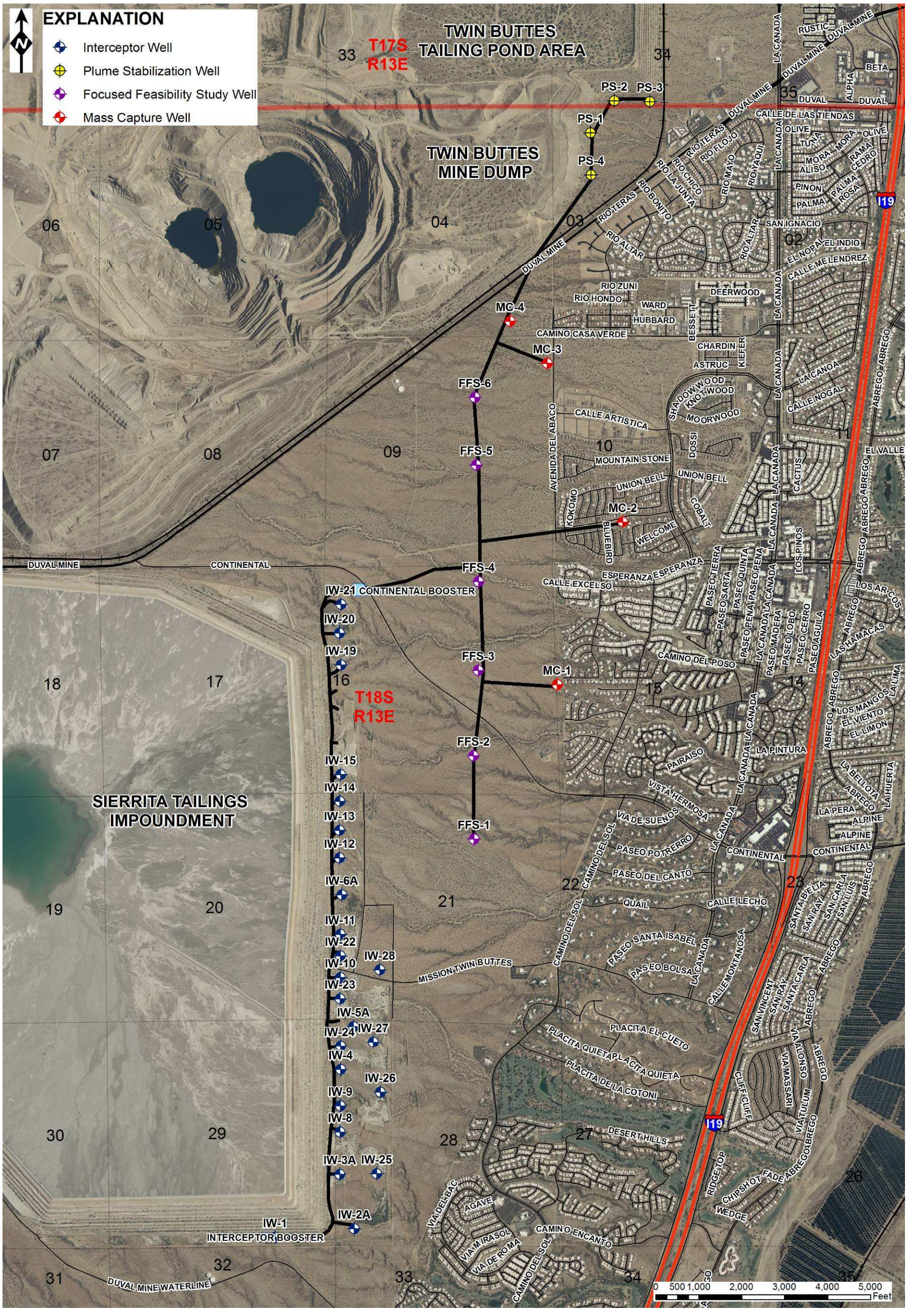


Figure 1. Sulfate Mitigation Well Field

TABLE 1. SULFATE MITIGATION WELL FIELD CONSTRUCTION INFORMATION

Well	Cadastral Location	ADWR Reg. No.	Well Depth (ft)	Well Dia. (in.)	Borehole Diameter (in.)	Casing Material	Upper Screen Depth (ft bls)	Lower Screen Depth (ft bls)	Pump Gallery/ Interval (ft bls)	Current Pump Setting (ft bls)	Filter Pack Material	Basin Fill Alluvium Base Depth (ft bls)	Drill Year	Well Age
IW-1	D-18-13 29DCD	55-623129	855	14		STEEL	234	843	No	480	GRAVEL	760	1978	35.3
IW-2A	D-18-13 28CCC	55-216464	1051	14	20	STEEL	350	1031	600-640	620	GRAVEL	1020	2008	5.6
IW-3A	D-18-13 28CBC	55-201732	1052	14	20	STEEL	400	1030	No	540	GRAVEL	820	2004	9.8
IW-4	D-18-13 28BCB	55-623132	946	14		STEEL	312	946	No	600	GRAVEL	490	1978	35.3
IW-5A	D-18-13 28BBB	55-219131	900	14.5	20	STAINLESS STEEL	382	890	620-640	630	TACNA GRAVEL	436	2010	3.5
IW-6A	D-18-13 21BCC	55-545565	497	12	20	STEEL	356	456	No	460	GRAVEL	456	1994	18.9
IW-8	D-18-13 28BCC	55-508236	783	14	20	STEEL	382	783	No	540	GRAVEL	759	1984	29.3
IW-9	D-18-13 28BCC	55-508238	853	14	20	STEEL	412	853	No	605	GRAVEL	740	1984	29.2
IW-10	D-18-13 21CBC	55-508237	831	14	20	STEEL	420	831	No	600	GRAVEL	730	1984	29.2
IW-11	D-18-13 21CBC	55-508235	605	14	20	STEEL	371	605	No	500	GRAVEL	563	1984	29.2
IW-12	D-18-13 21BCB	55-545555	600	12	20	STEEL	358	560	No	560	GRAVEL	498	1994	18.9
IW-13	D-18-13 21BBC	55-545556	497	12	20	STEEL	355	456	No	460	GRAVEL	452	1994	18.9
IW-14	D-18-13 21BBB	55-545557	549	12	20	STEEL	357	508	No	520	GRAVEL	509	1994	18.9
IW-15	D-18-13 16CCC	55-545558	547	12	20	STEEL	357	506	No	505	GRAVEL	507	1995	18.8
IW-19	D-18-13 16BCC	55-545562	540	12	20	STEEL	379	499	No	522	GRAVEL	498	1995	18.8
IW-20	D-18-13 16BCB	55-545563	502	12	20	STEEL	380	460	No	460	GRAVEL	470	1995	18.7
IW-21	D-18-13 16BBC	55-545564	601	12	20	STEEL	400	560	No	520	GRAVEL	520	1995	18.8
IW-22	D-18-13 21CBC	55-200554	590	14	20	STEEL	359	560	No	550	GRAVEL	550	2004	9.8
IW-23	D-18-13 21CCB	55-200555	964	14	20	STEEL	375	935	No	550	TACNA GRAVEL	420	2004	9.8
IW-24	D-18-13 28BBB	55-200556	884	14	20	STEEL	348	860	No	602	GRAVEL	410	2004	9.8
IW-25	D-18-13 28CBD	55-219596	782	16	24	STAINLESS STEEL	359	720	No	732	SILICA SAND	475	2010	3.0
IW-26	D-18-13 28BCD	55-219143	780	16	24	STAINLESS STEEL	340	720	No	732	SILICA SAND	475	2010	3.0
IW-27	D-18-13 28BBD	55-219136	720	14	22	STAINLESS STEEL	380	660	No	672	SILICA SAND	465	2010	3.0
IW-28	D-18-13 21CCA	55-219137	760	16	24	STAINLESS STEEL	380	700	No	712	SILICA SAND	680	2010	3.0
PS-1	D-18-13 03BBA	55-220861	1020	16.625	24	HSLA	560	980	640-680	890	SILICA SAND	914	2011	1.9
PS-2	D-17-13 34CDC	55-220862	1130	16.625	24	HSLA	560	1090	640-680	870	SILICA SAND	1090	2012	1.4
PS-3	D-17-13 34CDD	55-220863	1200	16.625	24	HSLA	520	1160	600-640		SILICA SAND	1160	2012	1.5
PS-4	D-18-13 03BCA	55-220864	1060	16.625	24	HSLA	560	1020	640-680	893	SILICA SAND	1020	2012	1.4
MC-1	D-18-13 16DAA	55-221660	915	16.625	24	HSLA	479	875	599-639	824	SILICA SAND	875	2013	0.5
MC-2	D-18-13 10CCB	55-221761	980	16.625	24	HSLA	479	940	600-640	855	SILICA SAND	940	2013	0.7
MC-3	D-18-13 09AAA	55-221661	870	16.625	24	HSLA	530	810	No	830	SILICA SAND	810	2012	1.0
MC-4	D-18-13 04DDC	55-220842	830	16.625	24	HSLA	560	770	No	810	SILICA SAND	770	2012	1.3
FFS-1	D-18-13 21ABC	55-221662	790	16.625	24	HSLA	448	729	No	753	SILICA SAND	730	2013	0.6
FFS-2	D-18-13 16DCA	55-221663	750	16.625	24	HSLA	470	690	No	703	SILICA SAND	680	2013	0.6
FFS-3	D-18-13 16ACD	55-221664	800	16.625	24	HSLA	510	740	No	762	SILICA SAND	736	2013	0.8
FFS-4	D-18-13 16ABA	55-221665	871	16.625	24	HSLA	540	830	640-680	788	SILICA SAND	830	2012	0.9
FFS-5	D-18-13 09DBA	55-221666	800	16.625	24	HSLA	569	739	No	775	SILICA SAND	740	2012	0.9
FFS-6	D-18-13 09ACA	55-221667	830	16.625	24	HSLA	528	769	No	750	SILICA SAND	770	2012	1.0

Notes: ft bls = feet below land surface; in. = inches; HSLA = High Strength Low Alloy Steel

SULFATE MITIGATION ACTION WELL FIELD OPERATION AND MAINTENANCE PLAN

2.0 DESCRIPTION

2.1 WELL INSTALLATION AND CONSTRUCTION

The interceptor wells were installed between 1978 and 2010, resulting in current well ages from three to 35 years. A number of wells have been replaced since their original installation, including IW-2, IW-3, IW-5, and IW-6 (replacement well names are designated with an "A" suffix in Table 1).

Based on available information, the majority of the interceptor wells were drilled by the reverse-circulation rotary method, but some early wells may have been drilled using the cable-tool method. All the wells installed prior to 2010 utilized low-carbon steel (LCS) casing. Stainless-steel casing was utilized for the wells installed in 2010 (IW-5A, IW-25, IW-26, IW-27, and IW-28), with the goal of extending well life. (The corrosive nature of the local groundwater is suspected to have contributed to past well failures.) IW-2, IW-3, IW-5, and IW-6 were replaced due to well integrity issues within 25 to 30 years of their installation.

Interceptor wells depths range from 497 to 1,052 feet. Well diameters range from 12 to 16 inches. Screen intervals consist of mill slots for the early wells and louvered openings for the recent wells. All wells are gravel-packed with standard industrial-graded gravel, Tacna gravel, or silica sand.

The PS, MC, and FFS wells were installed between 2011 and 2013. These wells were all installed utilizing a 16 5/8-inch-diameter, high-strength low-alloy (HSLA) steel casing and a Roscoe Moss "Hi Cap" louvered HSLA screen. Well depths range from 750 to 1,200 feet. The bottom of the screened interval is at the basin fill alluvium/bedrock contact.

Deeper wells include a pump gallery where the pumps are set in the short term. Once groundwater levels decline resulting in significant cascading water in the well, entrained air within the discharge may result. These conditions may result in excessive pump wear. Well sumps are provided at the bottom of each well and can serve as future pump galleries should these occur.

General well construction diagrams for all the wells, including stratigraphic information, are provided on the Well Field Data Plots in Appendix A. They are discussed in Section 3.3.

2.2 WELL YIELD AND GENERAL HYDROGEOLOGY

The current well yields of the active interceptor wells are tabulated in Table 2, along with the installed pump equipment and other parameters. Active interceptor well yields as of late October 2013 ranged

from 22 to 583 gallons per minute (gpm). The yields for the PS, MC, and FFS wells in Table 2 are yields estimated based in initial pumping tests. The yields for these wells range from 190 to 1,075 gpm.

All the active wells penetrate the saturated portions of the basin fill alluvium and bedrock in varying proportions. The basin fill alluvium in the area consists of unconsolidated to moderately consolidated sand, gravel, silt, and clay. The bedrock in the area consists of igneous and sedimentary rocks (Appendix A). Well yields have declined significantly in wells that have experienced reduced saturated thickness of the basin fill alluvium. This hydraulic response strongly suggests that the permeability characteristics of the basin fill alluvium are significantly greater than those of the bedrock in the area.

2.3 EXISTING INTERCEPTOR WELLS PUMP EQUIPMENT

In general, the following equipment is installed at each interceptor well:

- Vertical solid-shaft motor and lineshaft turbine pump, or submersible well pump and motor;
- Steel conduit (¾-inch or ½-inch diameter) installed in the well for obtaining manual groundwater level measurements with a water level sounder;
- Oil reservoir (drum) and feed tube for lubrication of the lineshaft; and
- Air-release assembly and in-line check valve assembly in discharge pipe.

2.4 EXISTING INTERCEPTOR WELLS INSTRUMENTATION AND MONITORING EQUIPMENT

In general, the following equipment is installed at each interceptor well:

- Sampling port at the wellhead to obtain groundwater samples;
- Flow rate transmitters and digital display for continuous flow rate monitoring; and
- Pressure gauge for determining wellhead pressure and reviewing discharge piping system conditions.

The monitoring and operational capabilities for each well are:

- Interceptor wells operation is supervised at central control at the mine site. Data are monitored in real-time and archived for historical recordkeeping and trending. (The automation and information interface allows Sierrita Water Company personnel to review the current and historical operation of each interceptor well.)
- Telemetry and automation functions for remote on/off control and flow data recording and archiving.
- Low pumping rate protection of the pump and motor via a low-flow trigger in the telemetry system. (Low flow generally triggers motor shutdown at measured pumping rates of 50 gpm or less for a period of 5 minutes. Wells pumping less than 50 gpm are not triggered.)

2.5 PS, MC, AND FFS WELL PUMP EQUIPMENT

In general, the following equipment is installed at each PS, MC, and FFS well:

- Vertical hollow-shaft motor and lineshaft turbine pump;
- PVC conduit (1¼-inch diameter) installed in the well for obtaining manual groundwater level measurements with a water level sounder;
- Oil reservoir (drum) and feed tube for lubrication of the lineshaft;
- Air-release assembly and in-line check valve assembly in discharge pipe;
- Drain valve assembly to drain manifold and/or transmission piping for maintenance; and
- Pressure-release valve (PRV) assembly to prevent damage to the well pumps from sustained high pressures.

2.6 PS, MC, AND FFS WELL INSTRUMENTATION AND MONITORING EQUIPMENT

In general, the following equipment is installed at each PS, MC, and FFS well:

- Sampling port to obtain groundwater samples;
- Flow rate transmitters and digital display for continuous flow rate monitoring;
- Pressure transmitter with digital display for continuous pressure monitoring;
- Pressure gauge for determining wellhead pressure and reviewing discharge piping system conditions; and
- Well level transmitter with digital display for continuous well level monitoring.

The monitoring and operational capabilities for each well are:

- PS, MC, and FFS well operation is supervised at central control at the mine site. (Data will be monitored in real-time and archived for historical recordkeeping and trending. The automation and information interface will allow Sierrita Water Company personnel to review the current and historical operation of each well.)
- PS, MC, and FFS well operation can also be supervised at the Continental Booster Station and Wells FFS-2, FFS-6, and PS-3. An automation and information interface has been supplied at these locations to allow Sierrita Water Company and ELW personnel to review the current and historical operation of each well.
- Telemetry and automation functions for remote on/off control and flow data recording and archiving. This remote on/off control can be performed at central control, the Continental Booster Station, and Wells FFS-2, FFS-6, and PS-3.

- Low pumping rate protection of the pump and motor via a low-flow trigger in the control system. (Low flow generally triggers motor shutdown at measured pumping rates of 25 percent or less of nominal design flow for a period of 1 minute.)
- High pumping rate protection of the pump and motor via a high-flow trigger in the control system. (High flow generally triggers motor shutdown at measured pumping rates of 150 percent or more of nominal design flow for a period of 1 minute.)

TABLE 2. SULFATE MITIGATION WELL FIELD PUMP EQUIPMENT INFORMATION

Well	Well Yield (gpm)	Design TDH (ft)	Design Pressure at Well Head (psi)	Static Head at Pump (ft)	Static Water Depth (ft bls)	Drawdown (ft)	Pumping Water Level (ft bls)	Specific Capacity (gpm/ft)	Pump Manufact.	Pump Model	Impeller Trim (in)	Wellhead Discharge Size (in)	Depth to Pump Setting (to bottom of pump, ft)	Column Pipe Size (in)	Column Pipe Thickness (in)	Column Pipe Material	Oil Tube Diameter (in)	Shaft Size (in)	Motor HP	Voltage	Full Load Amps	Service Factor Amps	Motor Nominal Efficiency
IW-1	414				385	59	444	7.0				6	490	6		Steel			100				
IW-2A	341				377	47	424	7.2				6	620	6		Steel			75				
IW-3A	583				398	54	452	10.8				8	560	8		Steel			150				
IW-4	70				391	20	411	3.4				6	635	6		Steel			100				
IW-5A	38				389	126	514	0.3	Grundfos			3	635	3		Fiberglass			20				
IW-6A	83				406	33	439	2.5	Grundfos			3	470	3		Fiberglass			20				
IW-8	400				385	56	441	7.2	Grundfos			4	555	3.5		Fiberglass			100				
IW-9	197				367	150	517	1.3	Goulds			6	605	6		Steel			100				
IW-10	289				414	69	483	4.2					600						75				
IW-11	339				406	63	468	5.3				6	560	6		Steel			100				
IW-12	138				395	46	441	2.6	Grundfos			4	555	3.5		Fiberglass			25				
IW-13	22				410	13	422	0.9					460						5				
IW-14	98				391	68	459	1.5	Goulds			4	480	3.5		Fiberglass			25				
IW-15	47				395	45	441	1.0	Grundfos			2	500	2 3/8		Fiberglass			10				
IW-19	146				415	24	439	6.2	Goulds			8	522	6		Steel			75				
IW-20	30				414	7	421	4.0	Grundfos			2	475	2		Fiberglass			7.5				
IW-21	101				nm	nm	nm	nm	Goulds			6	520	6		Steel			60				
IW-22	325				416	52	468	6.3	Simflo			8	552	8		Steel			75				
IW-23	127				385	99	483	1.3	Goulds			6	555	6		Steel			40				
IW-24	78				356	188	544	0.4	Grundfos			6	602	6		Steel			100				
IW-25	445	594			379	73	452	6.1	Simflo	SC12C-9	9.125	6	732	6		Stainless Steel	2 1/2	1 11/16	100	460	114		
IW-26	403	633			385	110	494	3.7	Simflo	SC12C-9		6	732	6		Stainless Steel	2 1/2	1 1/2	100	460	114		
IW-27	0	586							Simflo	SH8C-19		6	672	6		Stainless Steel	2 1/2	1 1/2	60	460			
IW-28	341	627			401	52	454	6.5	Simflo	SC12C-9		6	712	6		Stainless Steel	2 1/2	1 11/16	100	460	114		
PS-1	600	719	80	183	497	18	515	33.3	Simflo	SD12C-9	9.25	8	890	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
PS-2	600	730	87	200	487	23	510	26.1	Simflo	SD12C-9	9.3	8	870	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
PS-3	600	730	96	222	467	21	488	28.6	Simflo	SD12C-9	9.35	8		8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
PS-4	750	726	77	178	498	11	509	68.2	Simflo	SI12C-11	9.325	8	893	8	0.277	Stainless Steel	2 1/2	1 11/16	250	460	283	325	95.8
MC-1	900	673	79	183	419	22	441	40.9	Simflo	SI12C-12	9.04	8	824	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
MC-2	700	654	92	212	413	21	434	33.3	Simflo	SJ10C-15	8	8	855	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
MC-3	600	699	68	156	492	14	506	42.9	Simflo	SD12C-9	9.1	8	830	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
MC-4	600	705	55	127	531	20	551	30.0	Simflo	SD12C-9	9.1	8	810	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
FFS-1	900	643	68	157	397	41	438	22.0	Simflo	SI12C-11	9.188	8	753	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
FFS-2	900	658	62	142	417	56	473	16.1	Simflo	SI12C-11	9.29	8	703	8	0.277	Stainless Steel	2 1/2	1 11/16	200	460	222	255	95.8
FFS-3	300	675	58	133	462	50	512	6.0	Simflo	SC10C-13	7.703	8	762	6	0.28	Stainless Steel	2 1/2	1 11/16	100	460	114	131	95.4
FFS-4	190	689	50	115	498	42	540	4.5	Simflo	SG8C-28	5.83	8	788	6	0.28	Stainless Steel	2 1/2	1 11/16	100	460	114	131	95.4
FFS-5	1075	700	47	108	523	40	563	26.9	Simflo	SI12C-14	9.31	10	775	10	0.365	Stainless Steel	2 1/2	1 11/16	250	460	283	325	95.8
FFS-6	600	675	47	109	535	14	549	42.9	Simflo	SD12C-9	9	8	750	8	0.277	Stainless Steel	2 1/2	1 11/16	150	460	164	190	95.8

SULFATE MITIGATION ACTION WELL FIELD OPERATION AND MAINTENANCE PLAN

3.0 MAINTENANCE MONITORING

3.1 MONITORING REQUIREMENTS

Optimizing Well Field performance requires the routine monitoring of a set of relevant parameters on a well-by-well basis:

- Groundwater conditions (static water level, sulfate concentrations);
- Well hydraulics (well yield, pumping water level); and
- Pumping equipment operation and efficiency.

Measurement of yield and static and pumping water levels allows for the evaluation of the following derivative parameters:

- Specific capacity;
- Saturated thickness of the basin fill alluvium under non-pumping conditions; and
- Saturated thickness of the basin fill alluvium under pumping conditions.

The monitoring and evaluation of these parameters over time on a well-by-well basis provide important insight into potential maximum yield of a particular well given existing groundwater conditions.

This includes insight into changing well hydraulics resulting from progressive well plugging or the dewatering of the basin fill alluvium aquifer. Well plugging is caused by a buildup of inorganic encrustations (mineral salts) or bio-fouling byproducts on the slots of perforated well casings causing significant increases in well losses. Specific capacity can also be influenced by changing groundwater conditions, so the evaluation of potential well plugging must also consider parameters that describe the dewatering of the basin fill alluvium. The current and estimated specific capacities for the existing interceptor wells and PS, MC, and FFS wells, respectively, are tabulated in Table 2.

3.1.1 PUMPING EQUIPMENT EFFICIENCY

The parameters that describe pumping equipment operation and efficiency are:

- Flow rate;
- Pumping water level;
- Head pressure;
- Motor amperage; and

- Sand production.

The measurement of flow rate, pumping water level (lift requirement), head pressure, and motor amperage allows for the evaluation of pump operation and efficiency by considering the specifications (pump curves) of the equipment installed in a particular well. Pressure at the wellhead can also be used to review the performance of the transmission piping system. Performance pumping evaluations should be conducted before and after maintenance operations, and on an annual basis or when operating criteria change, to document well and pump performance and assist in decision-making for pump replacement and well remedial work.

Sand production can result in excessive wear on pumping equipment (impellers, bearings, etc.), resulting in a progressive loss in pumping capacity and pumping equipment efficiency, and eventually leading to pumping unit failure. To date, sand production has only been monitored sporadically on a qualitative basis. In the future, more quantitative measurements will be performed utilizing a portable Rossum sand indicator installed at the discharge piping for wells suspected to produce significant sand (See AWWA Standard for Water Wells, AWWA A 100, Appendix E, Section E.4.6).

Sand production testing will be performed at wells where and when it is suspected that pump life is being compromised. If sand production testing is measured to exceed 15 ppm, well rehabilitation efforts shall be made to mitigate. Mitigation measures include first identifying zones in the well that produce sand by video surveying (holes in casing of the well) and applying swedge patching (see Section 4.3).

3.2 MONITORING RESPONSIBILITIES

Regular inspection and record-keeping are vital to proper well operation and maintenance. Therefore, varying levels of site and equipment inspections and data logging should occur on a daily, monthly, and annual basis. Operators should provide documentation showing variations in pump and well performance. This information should be used to chart changes in groundwater conditions that influence well performance (e.g., decreases or increases in basin fill saturated thickness due to changes in regional water levels). A complete set of records should include a detailed log of well components to facilitate the ordering of parts for pump repairs as well as the identification of existing parts that may be wearing faster than normal.

Example formats for field data collection and wellhead status, and example spreadsheets showing compiled data are provided in Appendix B. Forms for well pump performance are provided in Appendix C.

3.2.1 ENVIRONMENT, LAND AND WATER DEPARTMENT RESPONSIBILITIES

ELW responsibilities center on regular data acquisition, the monitoring of trends, and notification regarding identified issues, with a focus on yield goals for the Well Field system and individual wells. The frequency of the tasks designed for this purpose is as follows:

3.2.1.1 Weekly (until Well Field performance at FFS, PS, and MC wells are stable; stability is defined when two sets of pumping water levels and yield measurements are within 5%).

- Record flow rate and totalized volume for the previous period for FFS, PS, and MC wells;
- Record total hours of operation (run-hours) for each well;
- Collect amperage readings at FFS, PS, and MC wells;
- Collect pressure readings at FFS, PS, and MC wells;
- Compare collected flow rate data to target flow rates for FFS, PS, and MC wells:
    - Flag those values that are 10 percent less than the target rate for further monitoring, and
    - Flag those values that are 20 percent less than the target rate for immediate action (See Section 5.0);
- Provide a list of the flagged well sites to the Sierrita Water Company for corrective action (See Section 5.0; and
- Collect pumping water level data at each well site.

3.2.1.2 Weekly

Weekly monitoring will be performed as listed below for any well flagged for more frequent monitoring during monthly monitoring until two sets of pumping water levels and yield measurements are within 5 %.

- Record flow rate and totalized volume for the previous period for any well flagged for more frequent monitoring during monthly monitoring;
- Record total hours of operation (run-hours) for each well flagged for more frequent monitoring during monthly monitoring;
- Collect amperage readings at each well site flagged for more frequent monitoring during monthly monitoring;
- Collect pressure readings at each well site flagged for more frequent monitoring during monthly monitoring;
- Compare collected flow rate data to target flow rates for each well flagged for more frequent monitoring during monthly monitoring.

3.2.1.3 Monthly

- Record flow rate and totalized volume for the previous period for each well;
- Record total hours of operation (run-hours) for each well;

- Collect amperage readings at each well site;
- Collect pressure readings at each well site;
- Compare collected flow rate data to target flow rates for each well:
    - Flag those values that are 10 percent less than the target rate for weekly monitoring, and
    - Flag those values that are 20 percent less than the target rate for corrective action (See Section 5.0);
- Provide a list of the flagged well sites to the Sierrita Water Company for corrective action (See Section 5.0). Graph average production flow rates and totalized volumes for these wells for comparison to previous months;
- Review and analyze run-hour data to determine which pumps (if any) are running significantly more or less often than the other pumps;
- Measure and record the pumping water levels of each well. (The measurement protocol is that the pumping water level be measured after the well has been pumping for at least 3 hours.)
- Measure and record static water levels for a certain set of nearby wells in the Well Field, alternating and staggering those wells that are taken briefly out of operation for this purpose. Strategic planning is required for this task to ensure that disruptions to the system are minimized through the proper choice of concurrent well shutoffs. This task should be timed to coincide with well outages conducted for maintenance purposes. (The measurement protocol is that the static water level be measured after the well has been shut down for at least 3 hours.)

3.2.1.4 Quarterly

- Evaluate the performance of each pump using the procedures provided in Appendix C.

3.2.1.5 Yearly

- Aggregate all data collected throughout the year for analysis and reporting, including well and pump operation information from the Sierrita Water Company;
- Compile a yearly summary of well and pump operation, Well Field pumping volume, aquifer status, and water quality results. Copies of the report should be kept in the ELW and Sierrita Water Company offices for long-term analysis of well field and aquifer status.
- Perform mitigation performance review for all wells as described in the Mitigation Plan (Clear Creek Associates, 2013).
- Evaluate pumping performance to assist in decision-making for pump replacement or well remedial work. More information on this decision making process is provided in Section 4.4. This evaluation may not be necessary for any wells that have been rehabilitated or repaired within the last 12 months.

- If needed, update O&M Plan.

3.2.2 SIERRITA WATER COMPANY RESPONSIBILITIES

Sierrita Water Company responsibilities center around the O&M activities of the well field and piping systems. **It is imperative that the Well Maintenance Record is kept current with all information from the wells as maintenance activities are performed.** The frequency for tasks assigned to Sierrita Water Company is as follows:

3.2.2.1 Weekly:

- Observe mechanical parameters (flow meter, pressure gauges, amperage) readings for wellheads and pressure gauges in the transmission piping system and
- Inspect transmission piping system for leaks or other malfunctions.

3.2.2.2 Bi-Weekly

- Inspect well discharge and transmission pipelines for:
    - Proper operation of valves and ancillary piping (hose bib operation for water quality sampling, gate valves, check valves, vacuum release, etc.),
    - Leaks at valves,
    - Proper operation of pressure gauges,
    - Proper operation of discharge manifolds,
    - Proper operation of magnetic flow meter. Service and maintain according to manufacturer's recommendations, and
    - Pressure-release valve limit switch operation;
- Replenish oil reservoir and verify that oiler rate is correct. Repair oiler or oiler piping, if necessary;
- Motor maintenance:
    - Service and maintain according to manufacturer's recommendations,
    - Check and record incoming voltages and check for voltage and current imbalances. If an unbalanced condition exists that cannot be corrected by adjustments to the plant equipment, then the power supplier needs to be contacted,
    - Inspect for leaking oil, unusually high surface temperature, unusual noises or smells, or excessive vibration. Pull and replace improperly functioning motors, as needed, with electrical assistance of rotation check and rewiring;
- Pump maintenance:
    - Service and maintain according to manufacturer's recommendations,

  - Review data received from ELW to coordinate timelines for the temporary removal of wells from active service to perform maintenance or rehabilitation,
  - Examine data received from ELW to assess possible problems with well functionality, and
  - Schedule repairs and well downtime;

- Well casing vent maintenance:
  - Check for proper operation,
  - Check screen for integrity, and
  - Ensure that all fittings are tight and sealed;

- Pump pedestal:
  - Check for developing cracks and repair/seal as necessary;

- Air release/vacuum breaker assembly:
  - Check for proper orientation,
  - Check screen integrity, and
  - Service per manufacturer's recommendations.

3.2.2.3 Monthly

- Provide a detailed log of changes to the pumping equipment to ELW.

3.2.2.4 General Responsibilities – As Needed

- Replace any leaking or malfunctioning parts or piping;
- Troubleshoot for corrective action any wells that failed to meet performance characteristics and were flagged by ELW
- Work with pump distributor and/or manufacturer to assess all items and materials used in well, both above and below ground, for possible upgrades to extend the life of the pumps and to rehabilitate the wells;
- Fabricate and replace improperly functioning discharge line manifolds.

3.2.3 WELL FIELD DATA MANAGEMENT

Well Field data management includes the input of all monitoring parameters into dedicated spreadsheets or a dedicated relational database for data storage, manipulation, and analysis. Industry-standard quality assurance/quality control (QA/QC) procedures must be performed prior to input into the dedicated database.

3.3 WELL PERFORMANCE EVALUATIONS

The effective evaluation of well performance on a well-by-well basis requires simultaneous, multi-parameter, time-series analyses of groundwater conditions, well hydraulics, and pumping equipment

parameters. The troubleshooting of suspected deterioration conditions can then be performed to identify effective remedial actions.

To effectively perform simultaneous multi-parameter analyses to evaluate well performance over time with respect to groundwater conditions and well hydraulics, well-specific data plots were developed. Copies of all data plots updated to December 15, 2013, are included in Appendix A.

The plots include:

- A well location map with cadastral location, Arizona Department of Water Resources (ADWR) registration number, and year of construction;
- A general well construction diagram with current pump setting and measured static water level data from 2004 to 2014;
- General stratigraphy with saturated thickness of basin fill alluvium under static conditions based on the most current static water level depth;
- A time series plot of available static and pumping water level data from 2004 to 2014 with base depth of basin fill alluvium;
- A time series plot of available yield and evaluated specific capacity data from 2004 to 2014 with target yield rate. (Specific capacity values were only calculated where yield and pumping water levels were measured on the same day and static water level was measured within a time frame of ±30 days. Future plots will include specific capacity values calculated from pumping and static water levels within a time frame of ±30 days of the yield measurement.)
- A time series plot of available sulfate concentrations and saturated thickness of basin fill alluvium under pumping conditions based on the most current pumping water level depth;
- Annotated information on past well failures, reconstructive maintenance, and well rehabilitation and cleaning activities, with dates.

A full set of data plots for all active wells will be continually updated as new data become available. The preparer of the plots and the reviewer of the data (currently BasinWells under contract to Sierrita) will communicate to ELW and Sierrita Water Company personnel when the performance of individual wells significantly does not meet target pumping rates established in the Mitigation Plan and will help troubleshoot the issues. Copies of the plots will be submitted to ELW and Sierrita Water Company staff on a bi-annual basis. Additional parameters (e.g., head pressure) may be added to the plots in the future.

TABLE 3. MONITORING RESPONSIBILITIES		
	ENVIRONMENT, LAND AND WATER DEPARTMENT	**SIERRITA WATER COMPANY**
WEEKLY	■ For early periods of operation of FFS, PS and MC wells and interceptor wells flagged for more frequent monitoring: Measure and record flow rate, totalized volume, total hours of operation (run-hours), amperage, and pressure readings.	■ Observe mechanical parameters (flow meter, pressure gauges, amperage) readings for wellheads and pressure gauges in the transmission piping system and ■ Inspect transmission piping system for leaks or other malfunctions.
MONTHLY/BIWEEKLY FOR SWC RESPONSIBILITIES	■ Measure and record flow rate, totalized volume, total hours of operation (run-hours), amperage, and pressure readings. Flag wells for more frequent monitoring. ■ Compare collected flow rate data to target flow rates for each well: o Flag those values that are 10 percent less than the target rate for weekly monitoring, and o Flag those values that are 20 percent less than the target rate for corrective action; ■ Provide a list of the flagged well sites to the Sierrita Water Company for corrective action. Graph average production flow rates and totalized volumes for these wells for comparison to previous months; ■ Review and analyze run-hour data to determine which pumps (if any) are running significantly more or less often than the other pumps; ■ Measure and record the pumping water levels of each well. (The measurement protocol is that the pumping water level be measured after the well has been pumping for at least 3 hours.) ■ Measure and record static water levels for a certain set of nearby wells in the Well Field, alternating and staggering those wells that are taken briefly out of operation for this purpose.	■ Inspect well discharge and transmission pipelines for: o Proper operation of valves and ancillary piping (hose bib operation for water quality sampling, gate valves, check valves, vacuum release, etc.), o Leaks at valves, o Proper operation of pressure gauges, o Proper operation of discharge manifolds, o Proper operation of magnetic flow meter. Service and maintain according to manufacturer's recommendations, and o Pressure-release valve limit switch operation; ■ Replenish oil reservoir and verify that oiler rate is correct. Repair oiler or oiler piping, if necessary; ■ Motor maintenance: o Service and maintain according to manufacturer's recommendations, o Check and record incoming voltages and check for voltage and current imbalances. If an unbalanced condition exists that cannot be corrected by adjustments to the plant equipment, then the power supplier needs to be contacted, o Inspect for leaking oil, unusually high surface temperature, unusual noises or smells, or excessive vibration. Pull and replace improperly functioning motors, as needed, with electrical assistance of rotation check and rewiring; ■ Pump maintenance: o Service and maintain according to manufacturer's recommendations, o Review data received from ELW to coordinate timelines for the temporary removal of wells from active service to perform maintenance or rehabilitation, o Examine data received from ELW to assess possible problems with well functionality, and o Schedule repairs and well downtime; ■ Well casing vent maintenance: o Check for proper operation, o Check screen for integrity, and o Ensure that all fittings are tight and sealed; ■ Pump pedestal: o Check for developing cracks and repair/seal as necessary; ■ Air release/vacuum breaker assembly: o Check for proper orientation, o Check screen integrity, and Service per manufacturer's recommendations
QUARTERLY	■ Evaluate the performance of each pump using the procedures provided in Appendix C	
YEARLY	■ Aggregate all data collected throughout the year for analysis and reporting, including well and pump operation information from the Sierrita Water Company; ■ Compile a yearly summary of well and pump operation, Well Field pumping volume, aquifer status, and water quality results. Copies of the report should be kept in the ELW and Sierrita Water Company offices for long-term analysis of well field and aquifer status. ■ Perform mitigation performance review to adjust pumping rates for all wells as described in the Mitigation Plan (Clear Creek Associates, 2013). ■ Evaluate pumping performance to assist in decision-making for pump replacement or well remedial work. ■ If needed, update O&M Plan.	

SULFATE MITIGATION ACTION WELL FIELD OPERATION AND MAINTENANCE PLAN

4.0 MAINTENANCE REQUIREMENTS

4.1 PUMP EQUIPMENT MAINTENANCE

Pump equipment maintenance activities may include the following and will be performed on an as-needed basis:

- The replacement of deteriorated or failed pump or motor equipment;
- The replacement of deteriorated or leaking column pipes; and
- The replacement of inoperative flow meters, wellhead pressure gauges, or well level transducers.

The sizing of replacement pump equipment should be performed under the review of an engineer or other professional familiar with well pump sizing criteria. When wells are taken out of operation for pump replacement, a step-rate pump testing should be performed to acquire current hydraulic data to form the basis of the pump replacement.

Procedure for performing and evaluating a step-rate pumping test are as follows:

- Measure static water level.
- Pump well at three to five step rates each over a constant period of time. (A test pump and test engine are mostly used for the test to allow for variable flow.) Yield rates shall bracket desired estimated target rate. Estimated target rate shall be evaluated based on historic and projected well hydraulic conditions.
- Measure pumping water levels at the end of each step-rate and calculate water levels drawdowns.
- Calculate specific capacity at each step rate and plot specific capacity versus yield rate.
- Optimum target rate is evaluated at the rate where well losses as a percentage of water level drawdown and yield are minimized. This can be identified at the point on the plot where curve of data begins to steepen.

When a pump equipment part is determined to be in need of replacement or rehabilitation, the Sierrita Water Company or Contractor should record the following information in the Sierrita Well Maintenance

Record using the Well Rehabilitation Report form provided for record-keeping during pumping equipment replacement or maintenance. A sample report is provided in Appendix D:

- The location of the maintenance event;
- The date of the maintenance event;
- The part replaced or rehabilitated and the reason for its replacement or rehabilitation; and
- The new tare distance of the sounding tube in relation to the survey control point for the well, if applicable.

A well outage to allow for repairs and/or rehabilitation provides a convenient opportunity to perform tasks that may only be performed on a non-operating well. The Sierrita Water Company should perform the following tasks whenever repairs or rehabilitation requires that a well be shut down:

- Notify ELW of the shutdown and startup of the well;
- Measure and record static water level for the well. (The measurement protocol is that the static water level be measured after the well has been shut down for at least 3 hours.)
- If well pump equipment has been removed, perform well review and rehabilitation in accordance with Section 5, documenting all activities; and
- Mark tare distance and date in a prominent place on the sounding tube in permanent marker.

Typically, deteriorated and leaking column pipe is realized in wells at a frequency of 3 to 4 years. Historically, column pipe has consisted of LCS pipe. Recently, fiberglass pipe has been used to good success in wells with limited yields (limited to small-diameter column pipe due to tensile strength limitations). The PS, MC, and FFS wells have been installed with stainless-steel column pipe.

4.2 WELL CLEANING AND REDEVELOPMENT

Well cleaning and redevelopment activities should be performed on a scheduled basis at a frequency of 3 to 4 years at each well or every time pumping equipment is removed. Well cleaning and redevelopment activities may include the following:

- Brush and bail cleaning;
- Dry ice treatment;
- Over-pumping redevelopment with a test pump;
- Acid treatment;
- Bio-fouling treatment with biocides or oxidizing compounds; and

- Pre- and post-cleaning well video surveys to visually inspect well conditions before and after treatment.

In the past, brush and bail cleaning and dry ice treatments have been applied to a select number of wells. Well performance improvements resulting from these cleaning and redevelopment activities are unclear due to the paucity of specific capacity values before and after treatment. Specific capacity values should be evaluated before and after all future well cleaning and redevelopment activities to provide a metric of the efficacy of these methods in improving well performance.

In the future, other well cleaning and redevelopment methods such as over-pumping redevelopment and acid and bio-fouling treatments will be evaluated to improve well performance.

4.3 WELL REHABILITATION

Well rehabilitation activities may include the following, which will be performed on an as-needed basis:

- Swedge patching (regain well integrity, control sanding); and
- Liner installation (regain well integrity, causes decreased diameter).

In those cases where well integrity has been compromised, swedge patching or liner installation may be prudent to extend well life and reduce costs. Sand development may also be controlled if the location of the sand invasion can be identified. Liner installation with a new casing will invariably reduce well diameter, limiting the size of the pumping equipment that can be installed. However, since many of the wells have experienced significant declines in yield as a result of the dewatering of portions of the basin fill alluvium, the installation of appropriately down-sized pump equipment may still be possible.

4.4 WELL REPLACEMENT

Well replacement will be necessary when the life cycle of a particular mitigation action extraction well is exceeded. As stated in Section 2.1, all interceptor wells installed prior 2010 were constructed with LCS casings. Based on the life cycles of the interceptor wells that have been replaced due to well integrity issues (IW-2, IW-3, IW-5, and IW-6), the typical life cycle of an interceptor well constructed with LCS casing is about 25 to 30 years.

Prioritizing well replacements should consider the review of previously performed or new well video surveys to evaluate current well integrity. Priority of replacement should also consider the potential effects on yield of the replacement wells from the activation of neighboring wells due to well interference.

To extend well life, all future wells shall be constructed with HSLA steel or stainless-steel casings. The life cycle of a well constructed with HSLA casing can approach 50 years under normal operating conditions, extending the current well life cycle of interceptor wells constructed with LCS by about 15 to 20 years. The life cycle of a well constructed with stainless-steel casing can approach 60 or more years under

normal operating conditions, extending the current well life cycle of interceptor wells by about 25 to 30 years. Well designs shall be based on current and projected local hydrogeologic conditions.

SULFATE MITIGATION ACTION WELL FIELD OPERATION AND MAINTENANCE PLAN

5.0 CORRECTIVE ACTION GUIDE

5.1 DECLINING WELL PERFORMANCE

Declining well performance may be the result of any one or a combination of the following:

- The dewatering of the basin fill alluvial aquifer;
- Well plugging from a buildup of inorganic encrustations (mineral salts) or bio-fouling byproducts on the slots of perforated well casings;
- Pump equipment deterioration or failure (e.g., pump impeller wear, column pipe leaks, etc.); and
- Increase in wellhead pressure.

As stated in Section 4.1.1, specific capacity is considered one of the most important derivative well hydraulic parameters in evaluating causes for declining well performance. Specific capacity, along with trends in static water levels, can provide important insight into changing groundwater conditions, alterations in well hydraulics from well plugging, and imminent pump equipment failure. Possible causes of identified trends in specific capacity are listed below:

- Declining trends in specific capacity can be attributed to either aquifer dewatering or well plugging;
- Declining trends in specific capacity with little to no change in static water levels suggest well plugging; and
- No change or an increase in specific capacity and minimal or no change in static water level, but a decline in instantaneous flow rate suggests progressive or imminent pump equipment failure. Pumping levels would be expected to rise in this case.

Specific capacity will necessarily decline when instantaneous flow rate is increased, which increases well losses (head loss from more turbulent flow) and should be considered in any evaluation.

These corollaries along with the parallel evaluation of other parameters can provide the required information to properly identify the cause(s) of declining well performance and allow for the development and application of effective remedial actions prior to an unexpected well outage.

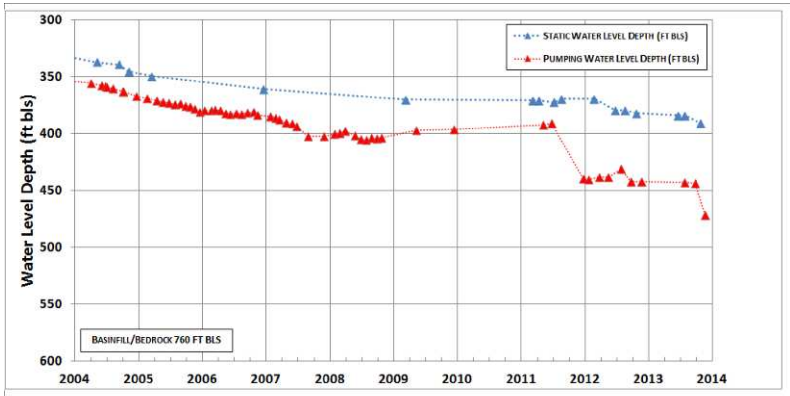
5.2 PUMPING EQUIPMENT AND TRANSMISSION PIPELINE DETERIORATION OR FAILURE

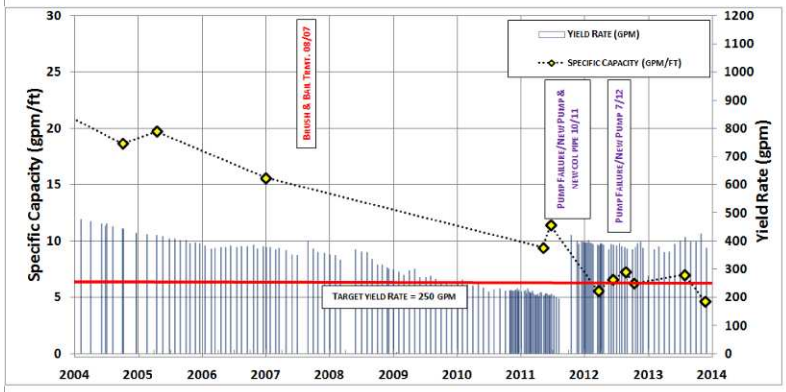
If it has been determined that an identified well performance issue is caused by failing pumping equipment, the following common causes may be considered:

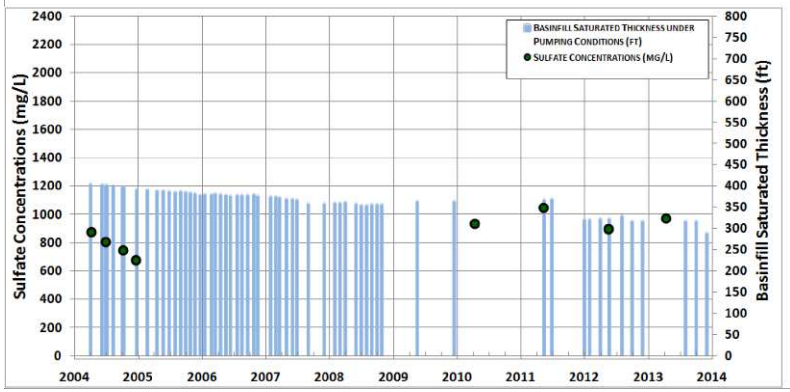
- Improper shaft lubrication causing premature wear of bearings and loss of torque and efficiency and potential catastrophic failure of shaft and bearings. Check oil reservoir drip for proper function.
- Improper pump installation methods may cause leakage at column pipe collars from improper tightening or friction losses and inefficiency due to crooked shafts.
- Poor pump selection for current operating conditions: With proper flow rate and water level and pressure readings, the operating point of a pump on its pump curve can be determined. A pump in an inefficient range on the pump curve will exhibit poor performance and shortened operating life. If this is the case, a more suitable pump should be selected and installed. A copy of the pump curve should be provided in the Well Maintenance Record. The operating point of the pump on its curve should be evaluated periodically.
- Poor motor performance: If a pump is in the correct range on its pump curve, the amperages may be checked to ensure that the value is within the expected operating range. Poor performance may indicate that the replacement or rehabilitation of the motor or other electrical equipment is needed.
- High-pressure measurements in the discharge piping or the transmission pipeline may be due to improper functioning of the air-release valves. If gradually increasing pressures are recognized, all air-release valves along the discharge pipeline should be checked to confirm proper functioning. Sudden increases in pressure are likely related to valve closures in the system, and shut-off valves should be checked for position.
- PS, MC, and FFS were activated in December 2013. Well interference effects may negatively affect the water levels and flow rates of neighboring wells by altering local groundwater conditions. These effects will be evaluated once these wells are in full operation.

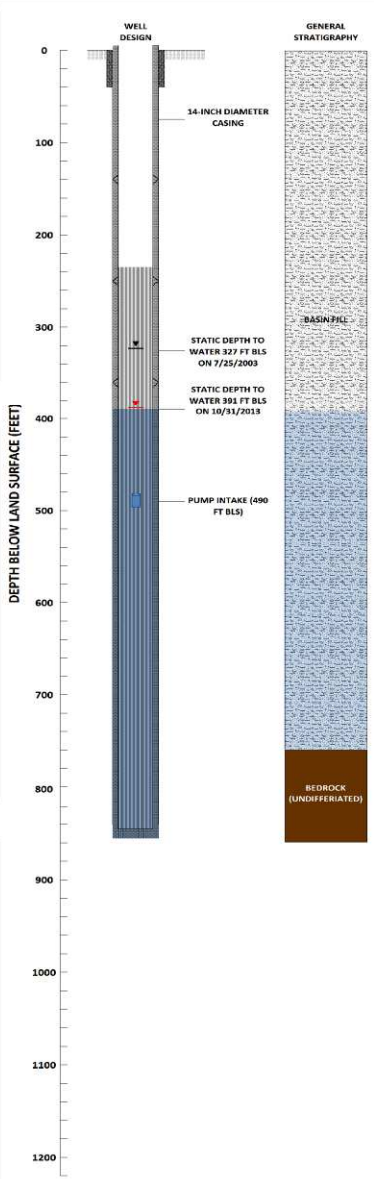
APPENDIX A

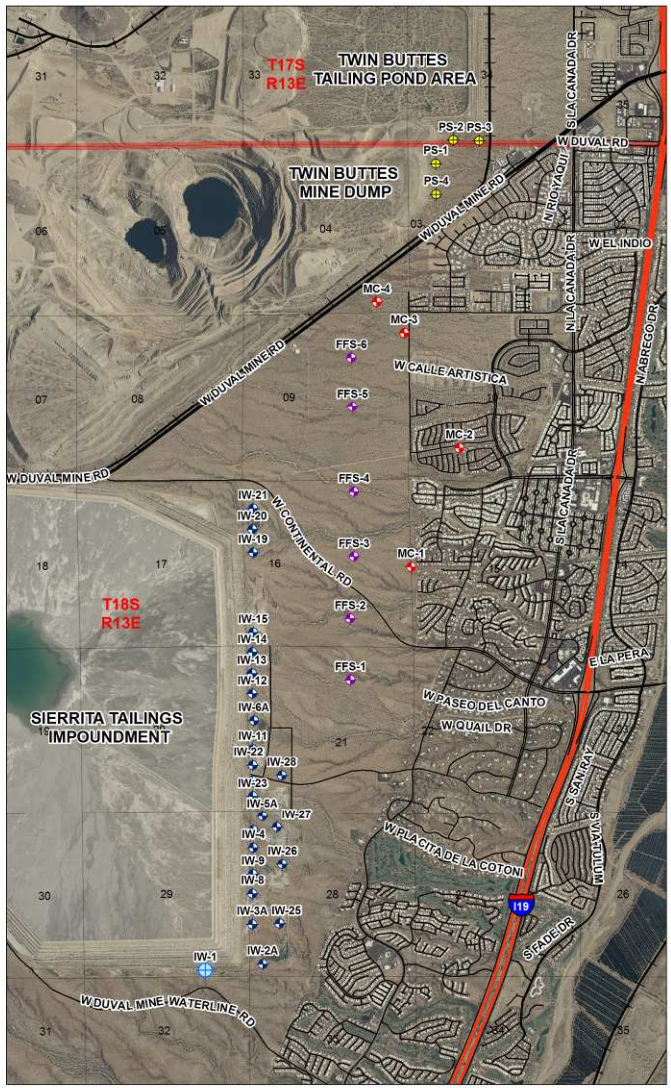
Sulfate Mitigation Action Well Field Plots (Version Date: December 15, 2013)











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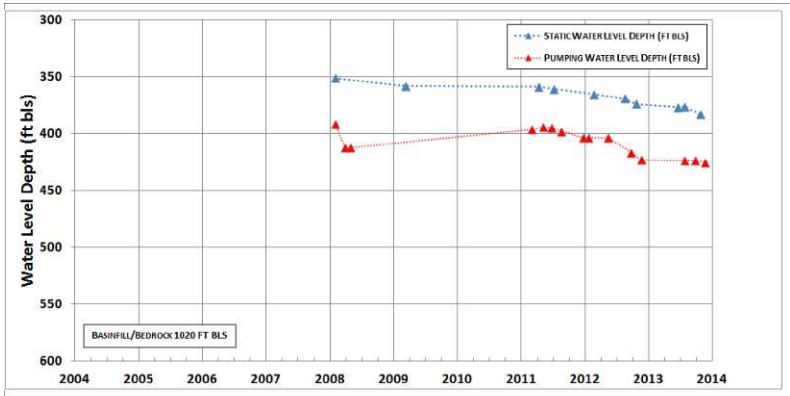
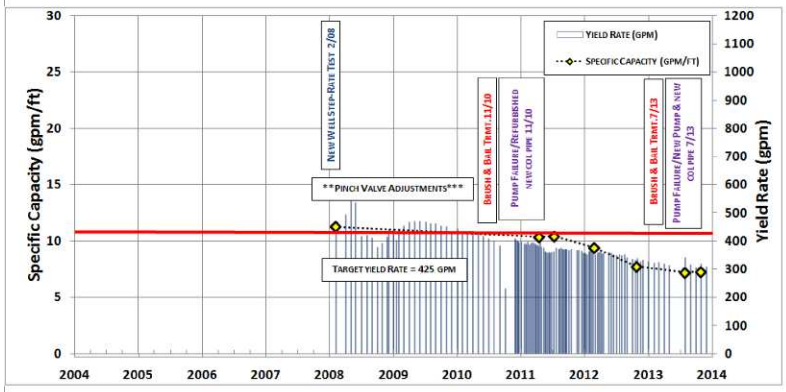
FREEPORT-McMoRan COPPER & GOLD

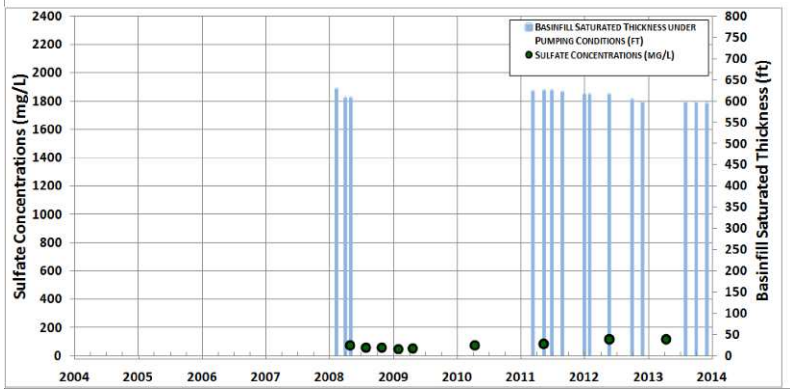
IW-1: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

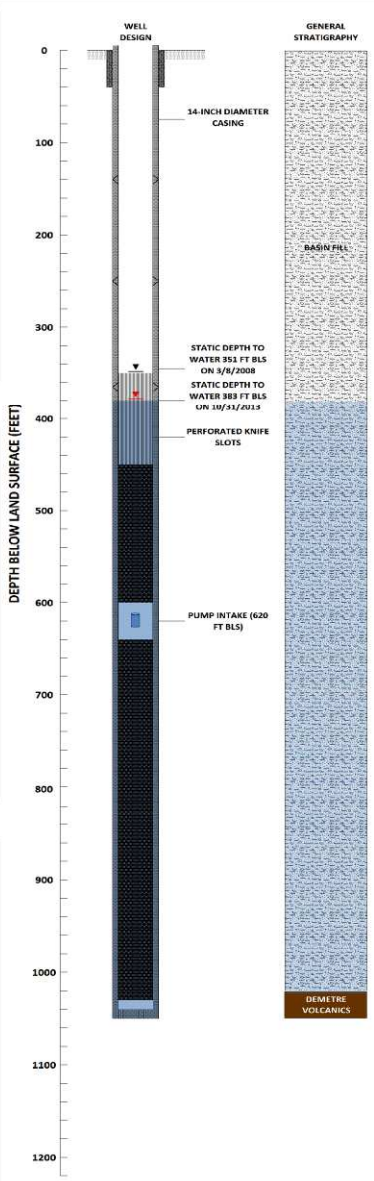
VERSION DATE: DECEMBER 15, 2013

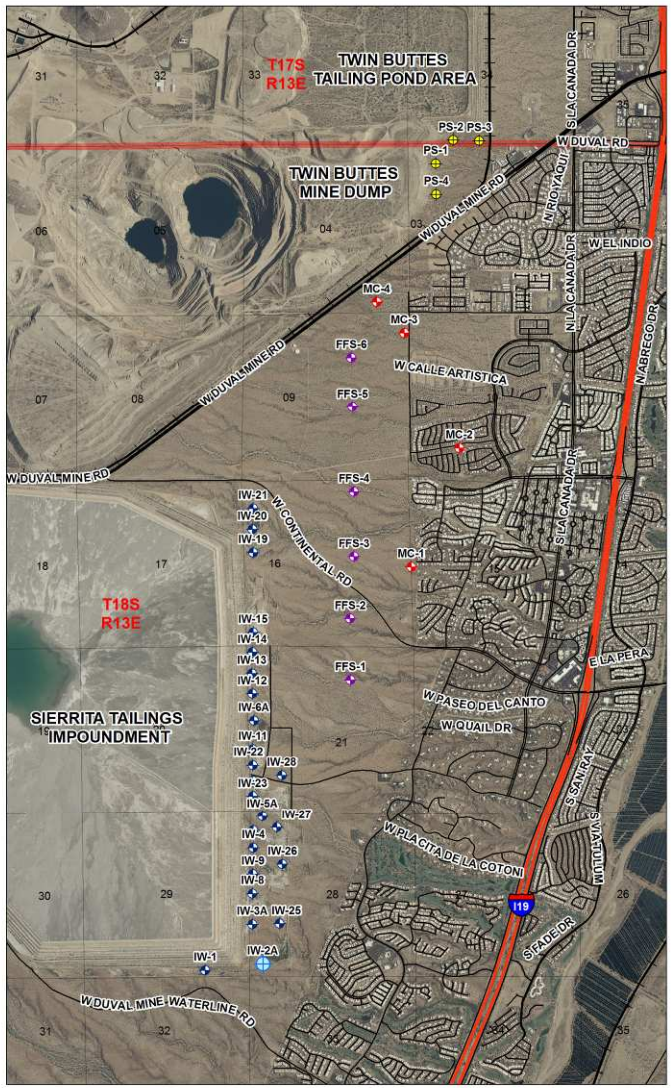
CADASTRAL: D-18-13 29DCD
ADWR REG. NO.: 55-623129
DRILL YEAR: 1978











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FREEPORT-McMoRan COPPER & GOLD

IW-2A: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 28CCC
ADWR REG. NO.: 55-216464
DRILL YEAR: 2008

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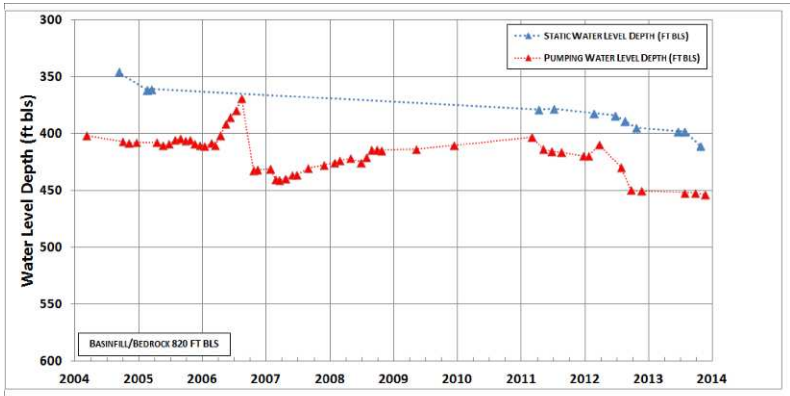
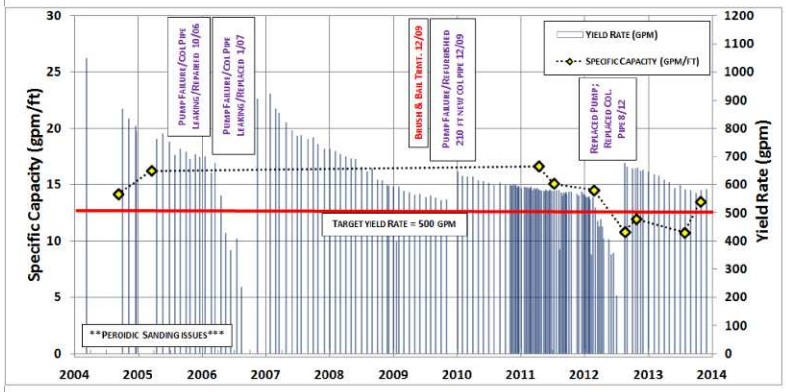
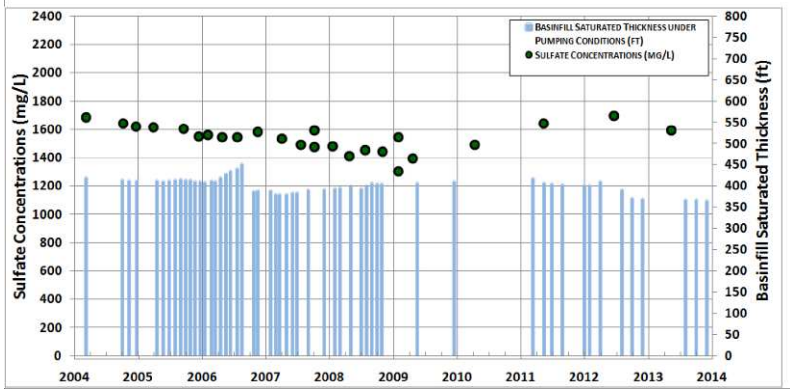
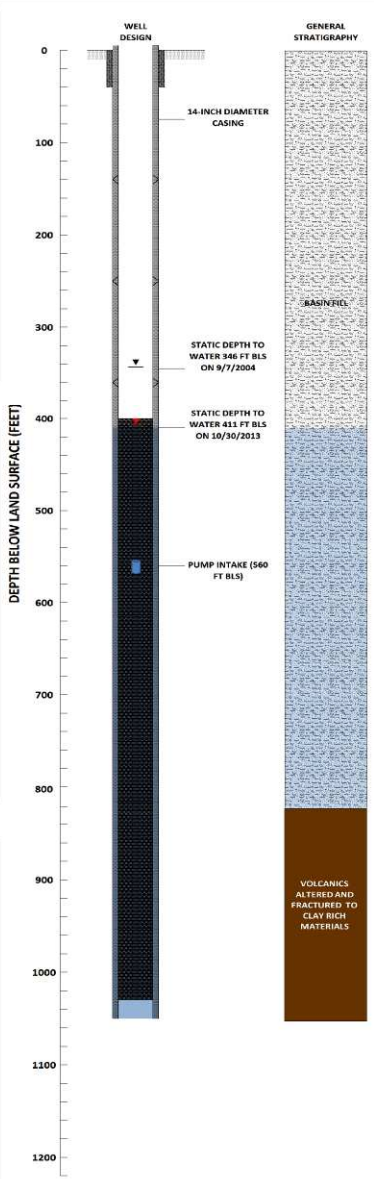
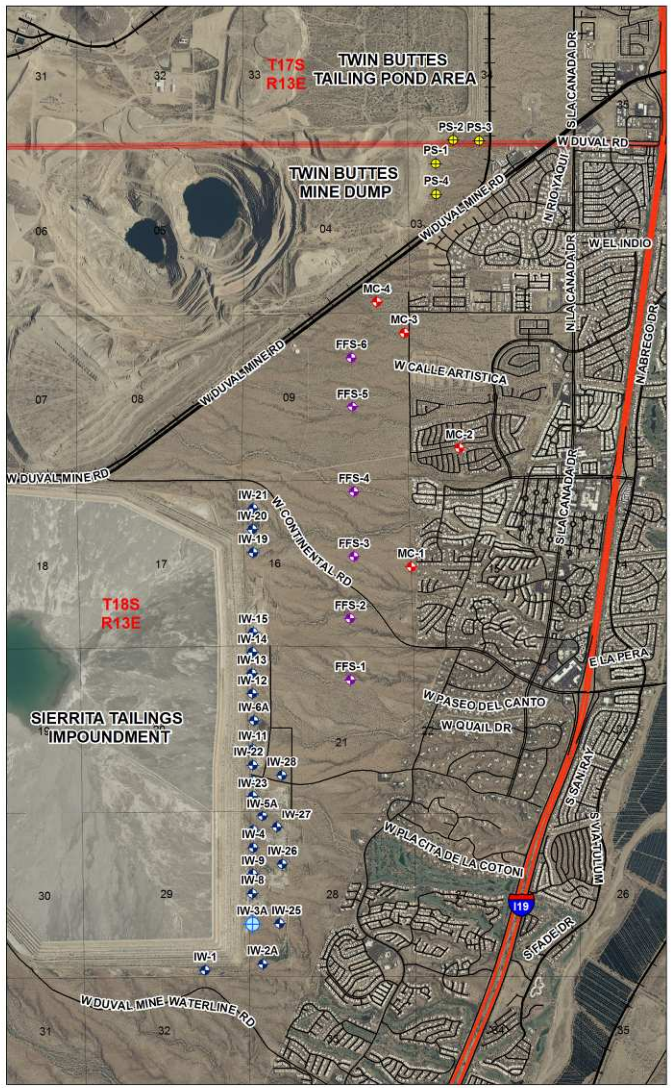
Engineering and Environmental Consultants











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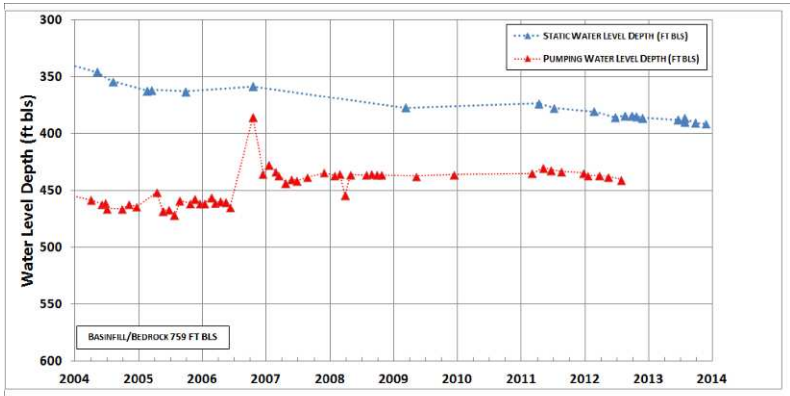
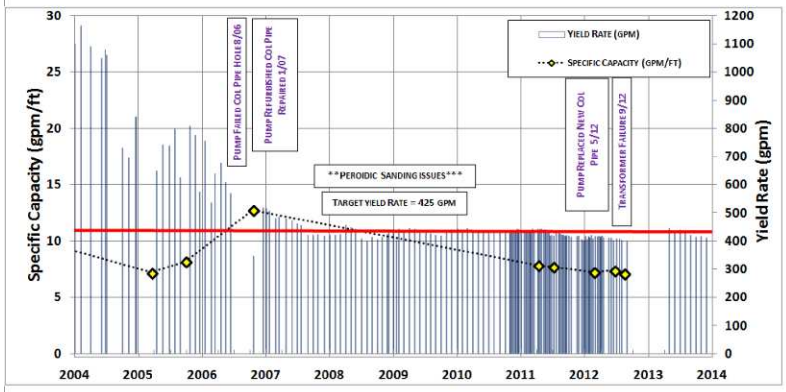
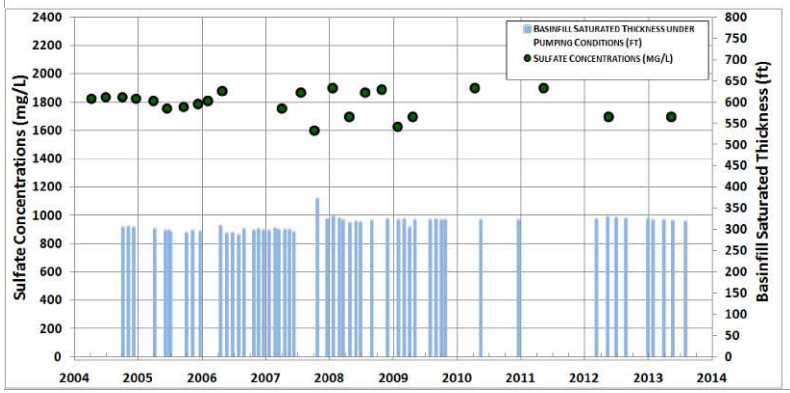
IW-3A: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

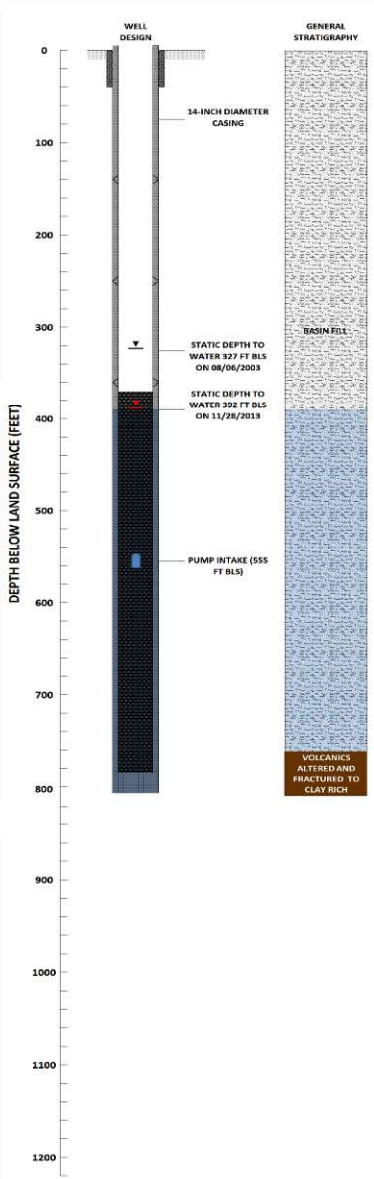
VERSION DATE: DECEMBER 15, 2013

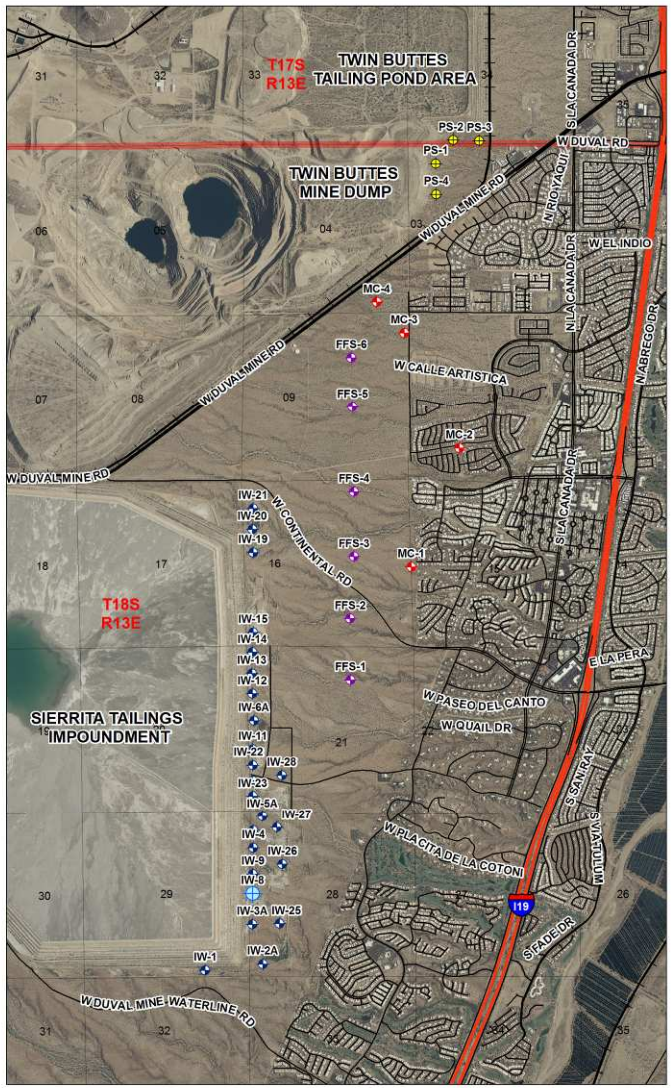
CADASTRAL: D-18-13 28CBC
ADWR REG. NO.: 55-201732
DRILL YEAR: 2004











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IW-8: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 28BCC
ADWR REG. NO.: 55-508236
DRILL YEAR: 1984

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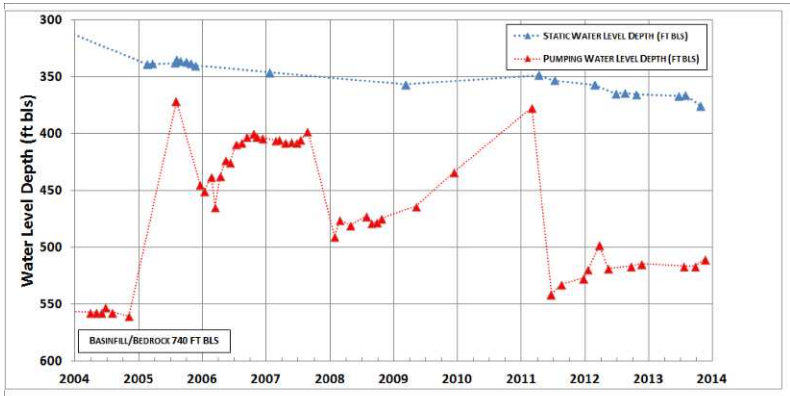
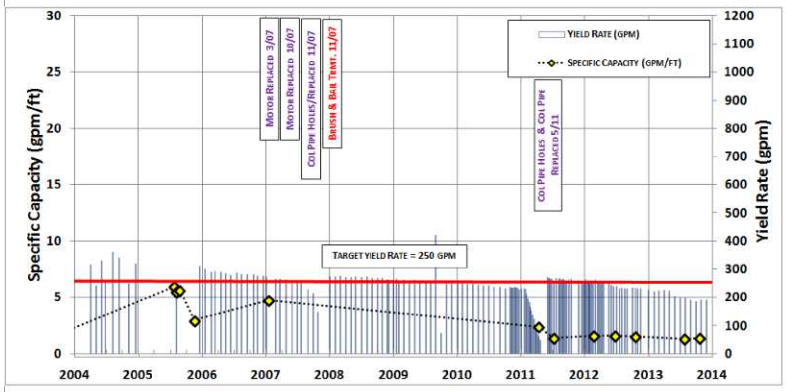
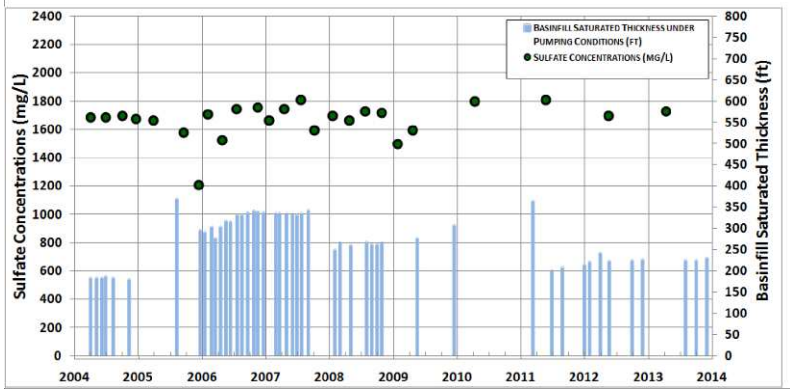
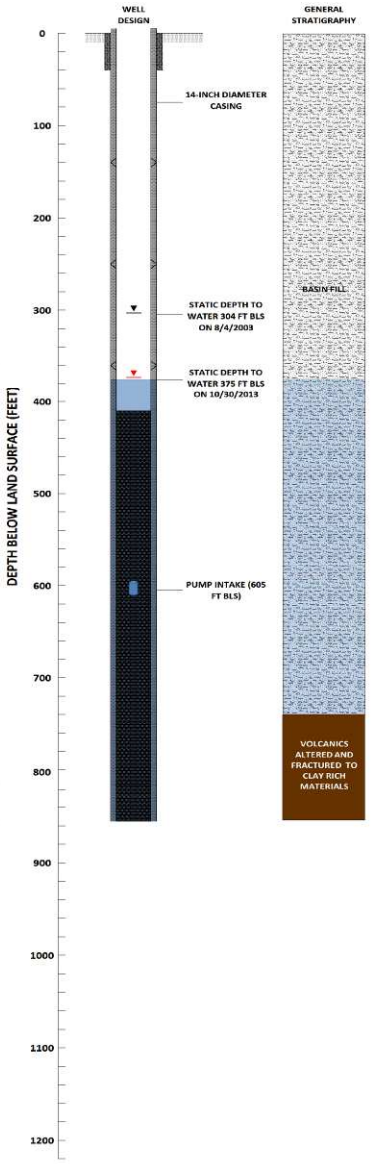
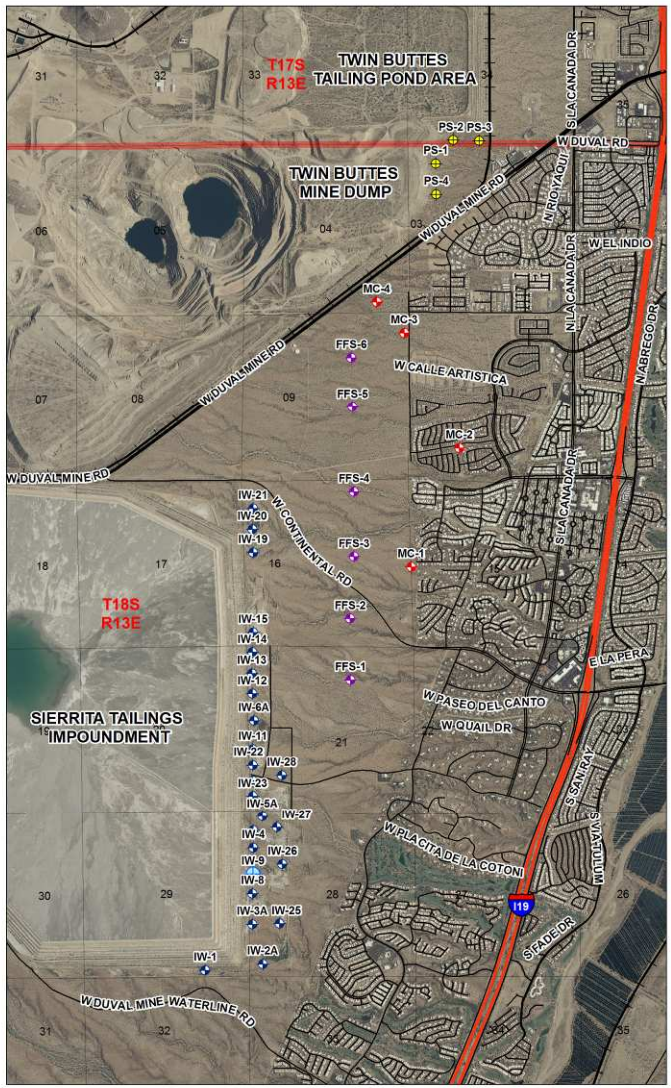
Engineering and Environmental Consultants











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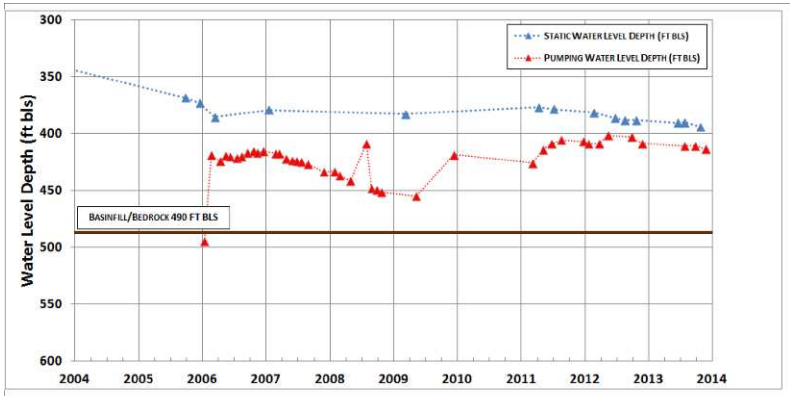
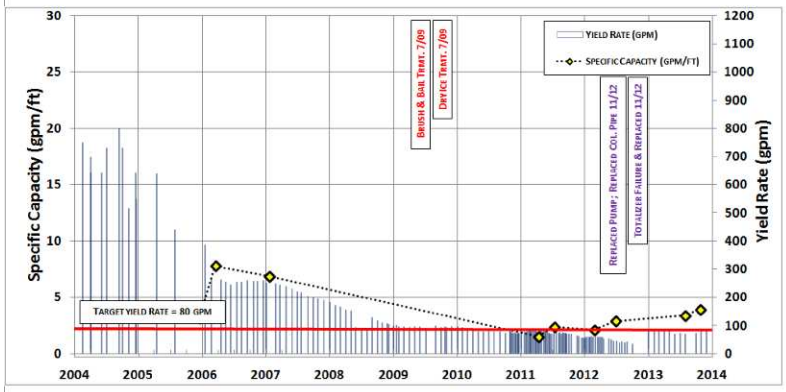
FREEPORT-MCMORAN COPPER & GOLD

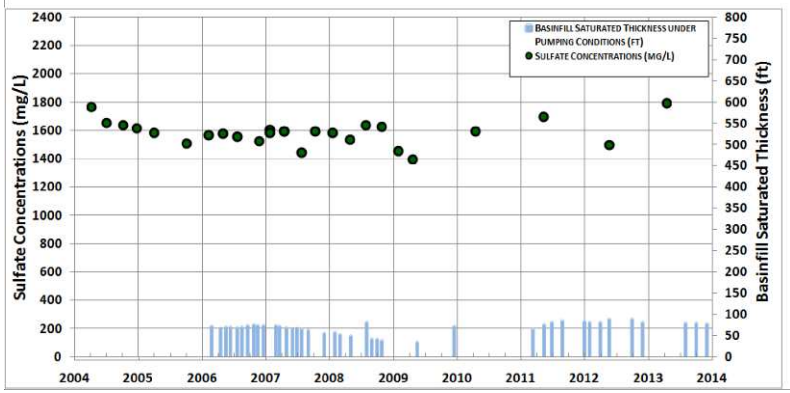
IW-9: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

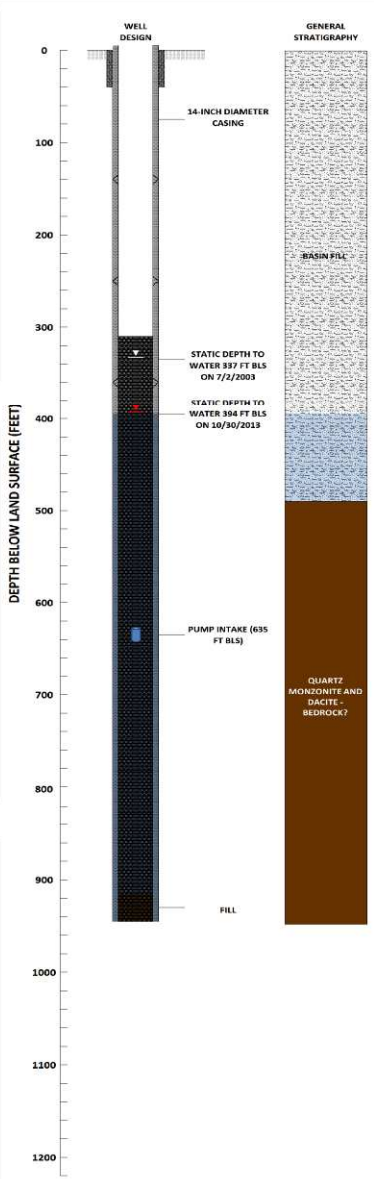
VERSION DATE: DECEMBER 15, 2013

CADASTRAL:D-18-13 28BCC
ADWR REG. NO.: 55-508238
DRILL YEAR: 1984









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FREEPORT-MCMORAN COPPER & GOLD

IW-4: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL:D-18-13 28BCB
ADWR REG. NO.: 55-623132
DRILL YEAR: 1978

BasinWells ASSOCIATES PLLC

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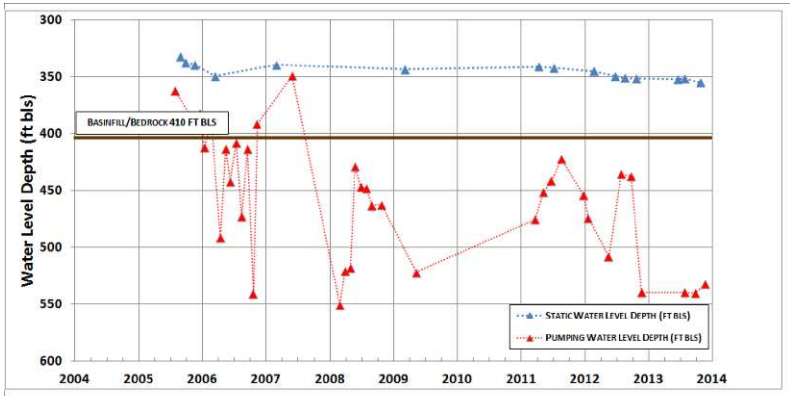
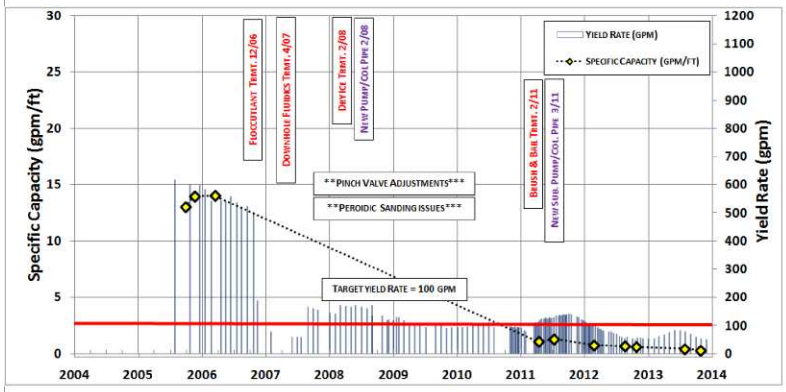
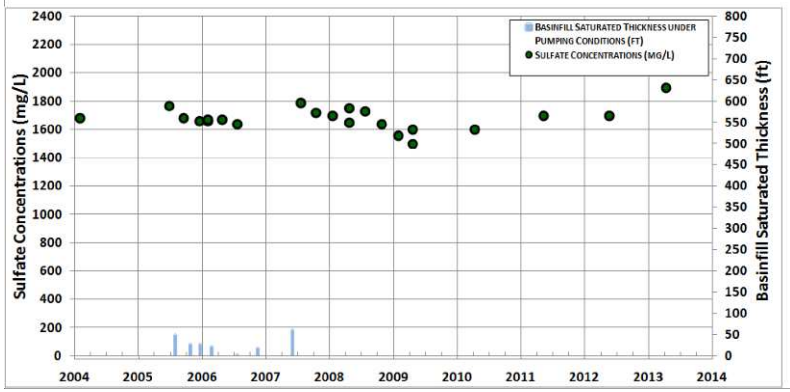
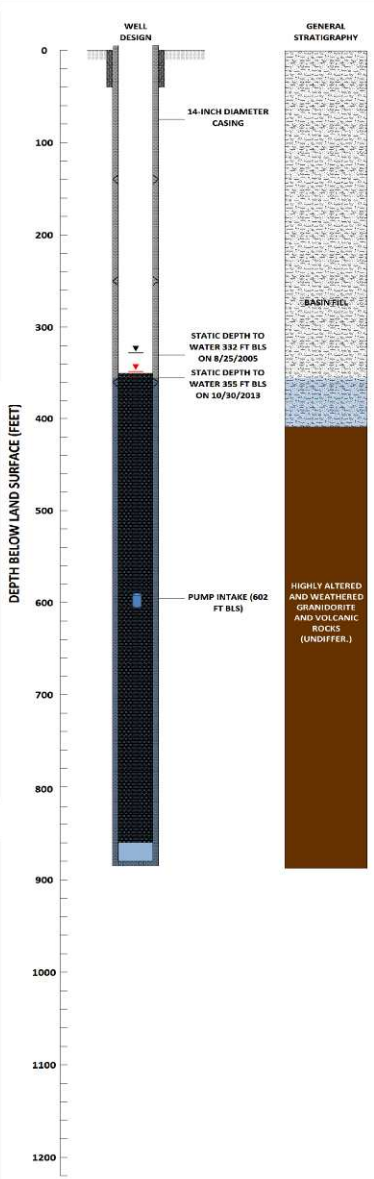
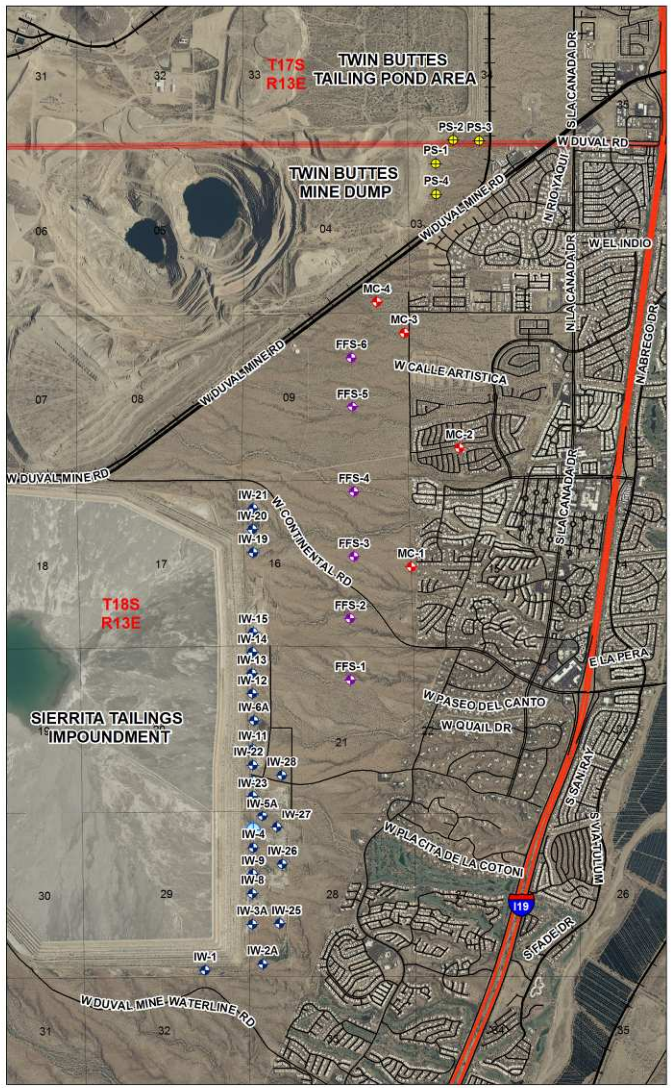
Engineering and Environmental Consultants











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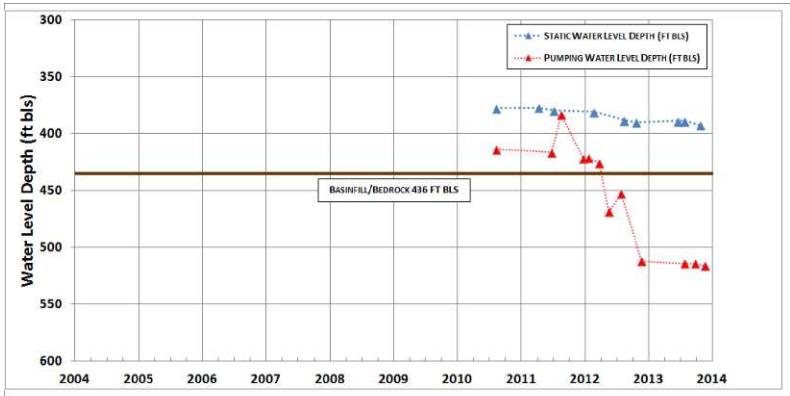
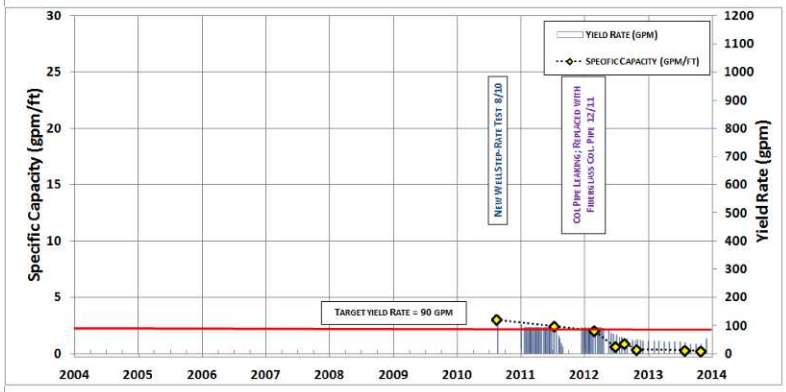
FREEPORT-MCMORAN COPPER & GOLD

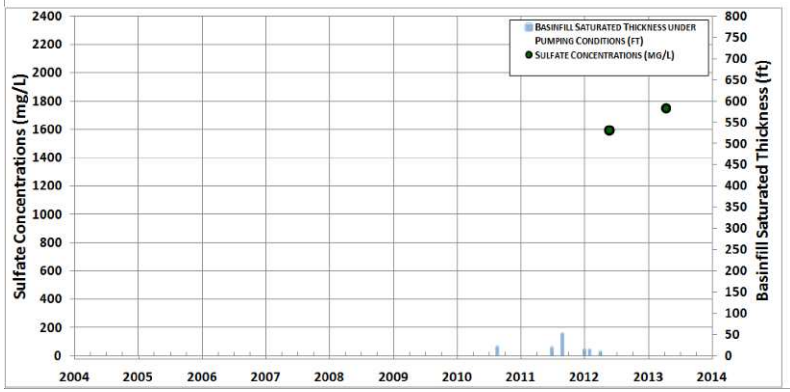
IW-24: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

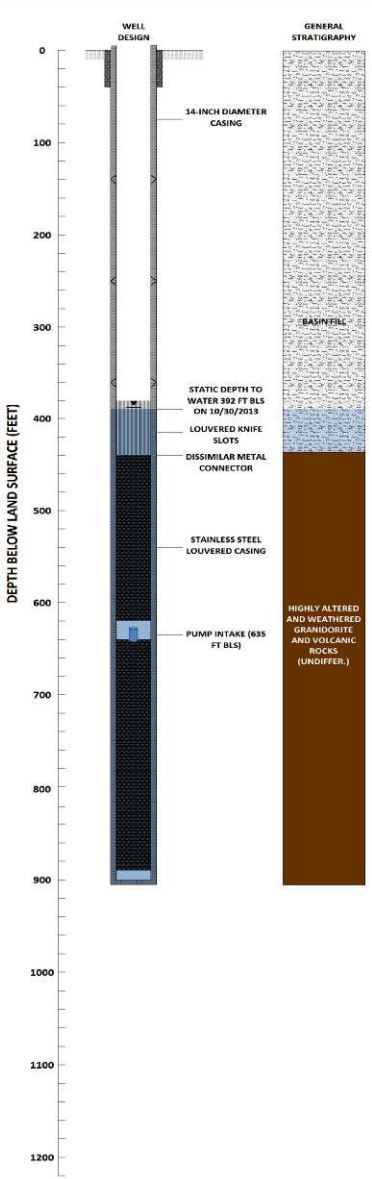
VERSION DATE: DECEMBER 15, 2013

CADASTRAL:D-18-13 28BBB
ADWR REG. NO.: 55-200556
DRILL YEAR: 2004









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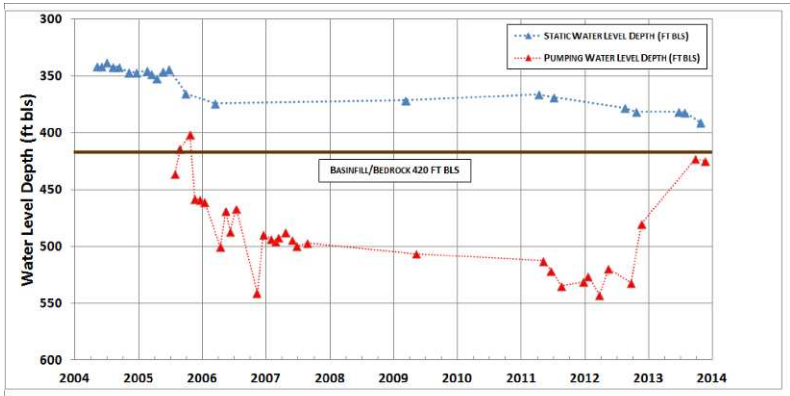
FREEPORT-McMoRan COPPER & GOLD

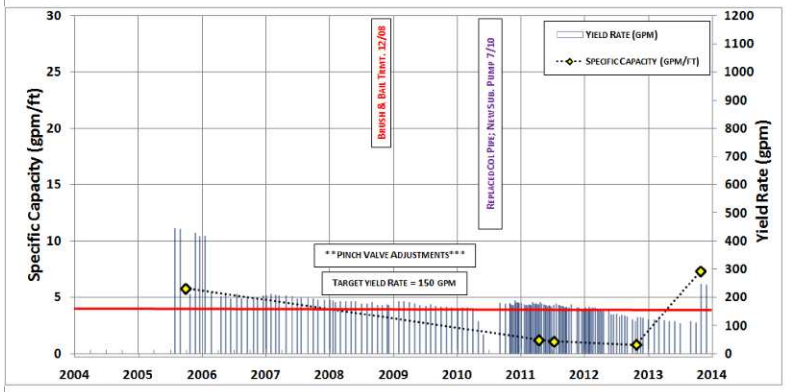
IW-5A: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

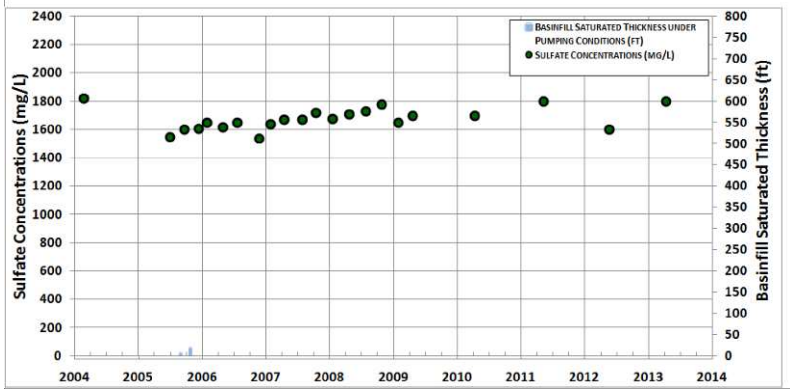
VERSION DATE: DECEMBER 15, 2013

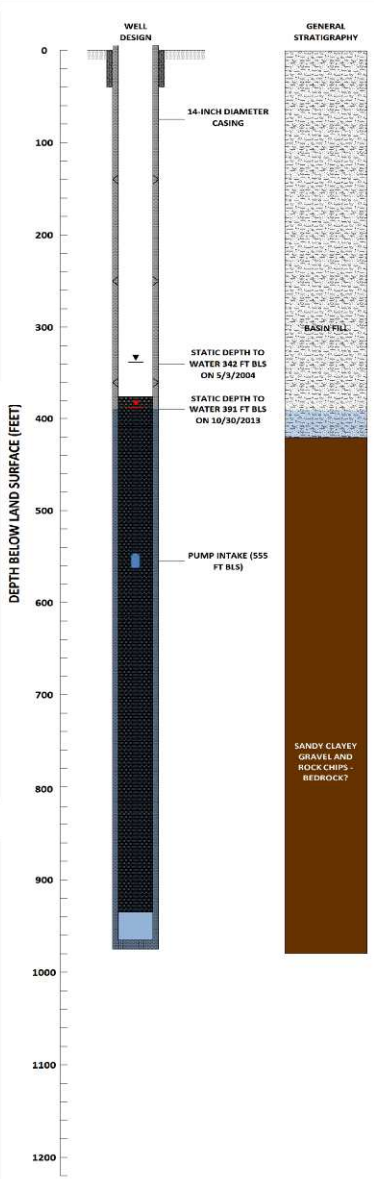
CADASTRAL:D-18-13 28BBB
ADWR REG. NO.: 55-219131
DRILL YEAR: 2010

BasinWells ASSOCIATES PLLC
WestLand Resources, Inc.
Engineering and Environmental Consultants









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SPECIALISTS IN GROUNDWATER DEVELOPMENT

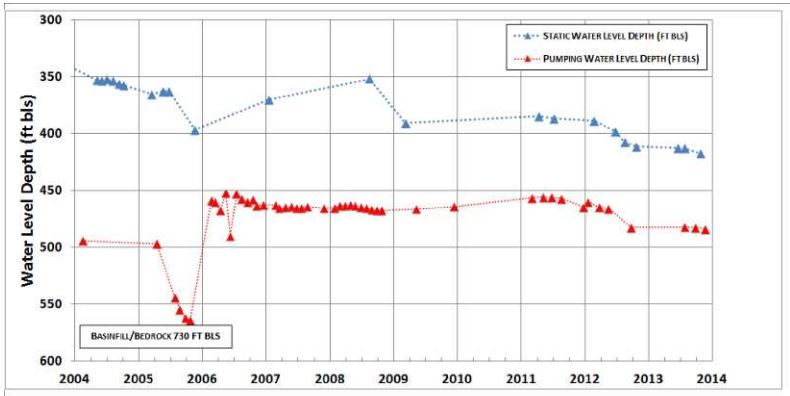
FREEPORT-MCMORAN COPPER & GOLD

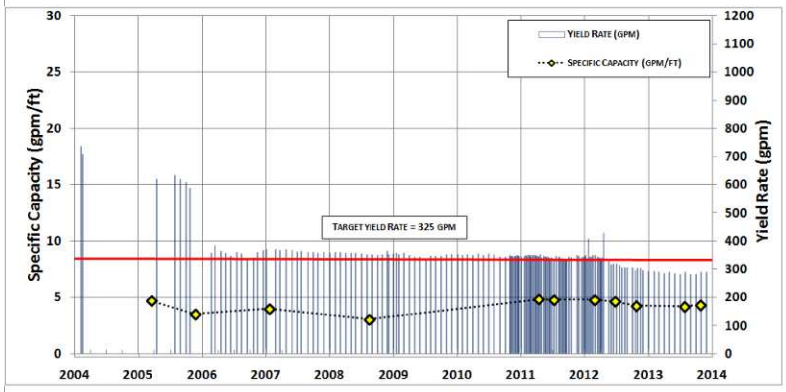
IW-23: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

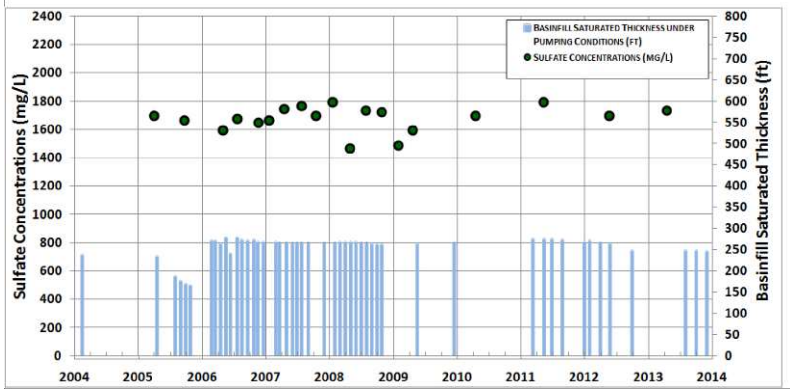
VERSION DATE: DECEMBER 15, 2013

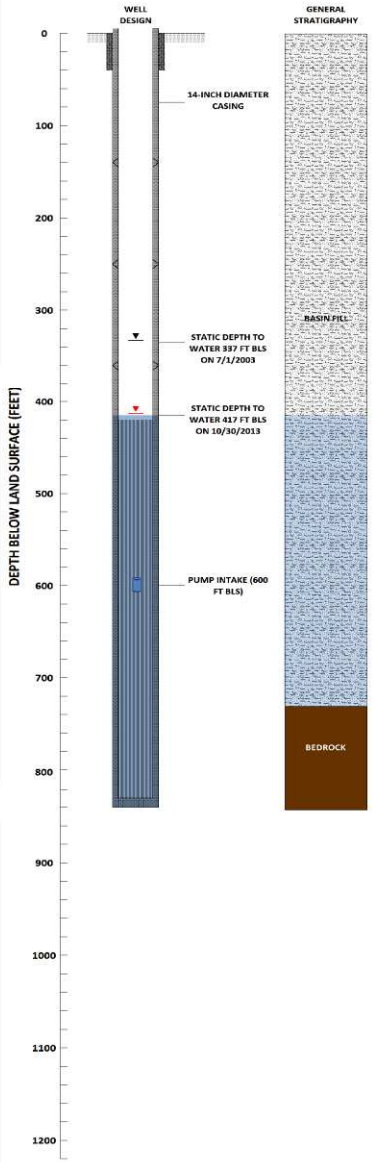
CADASTRAL:D-18-13 21CCB
ADWR REG. NO.: 55-200555
DRILL YEAR: 2004

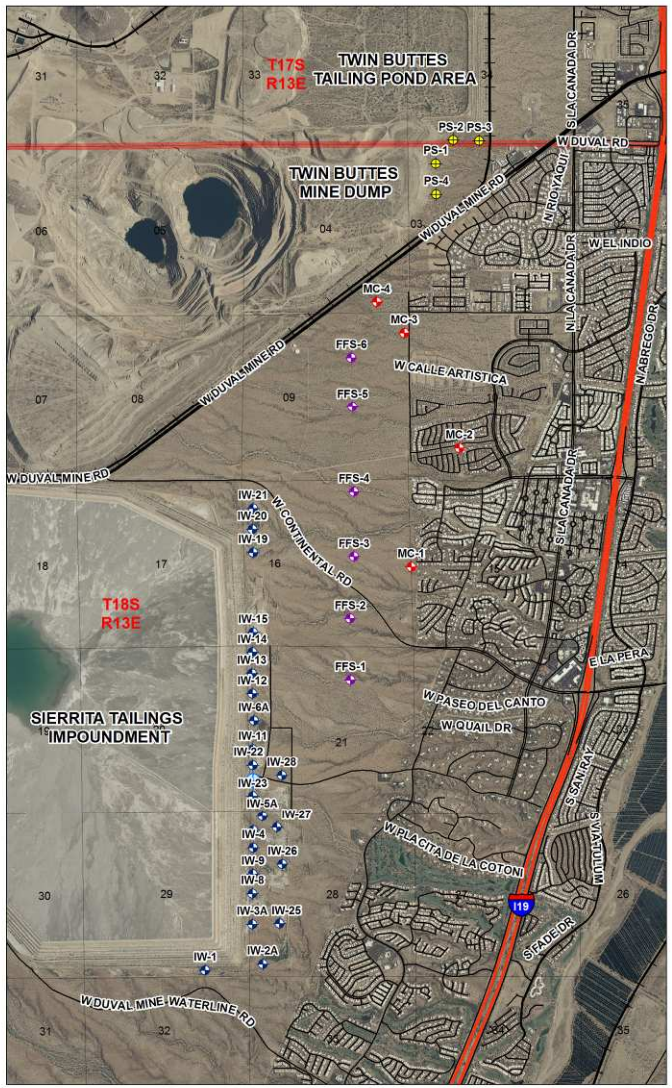
BasinWells ASSOCIATES PLLC
WestLand Resources, Inc.
Engineering and Environmental Consultants











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SPECIALISTS IN GROUNDWATER DEVELOPMENT

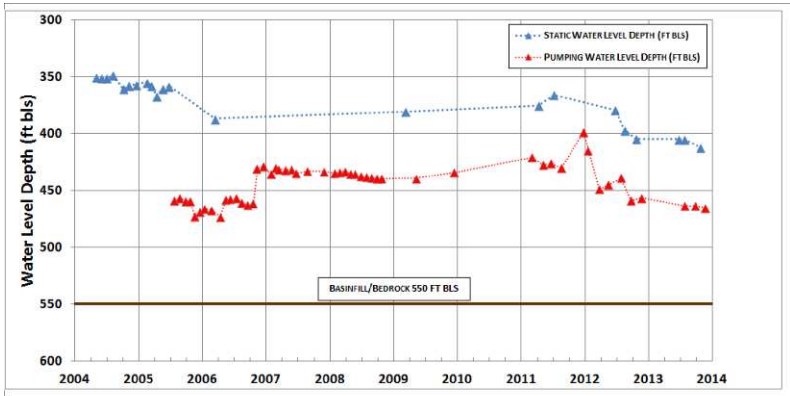
FREEPORT-MCMORAN COPPER & GOLD

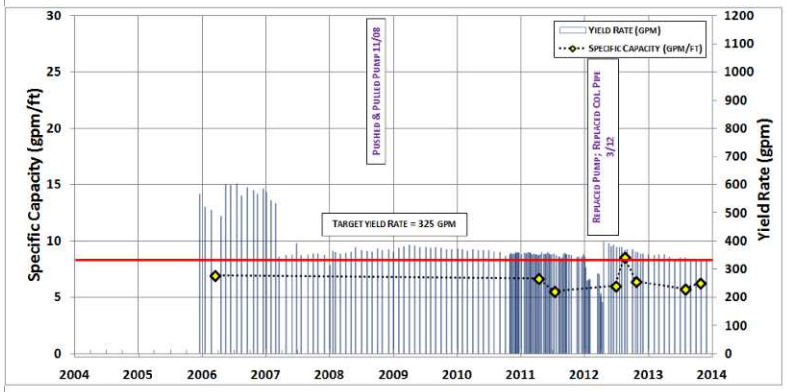
IW-10: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

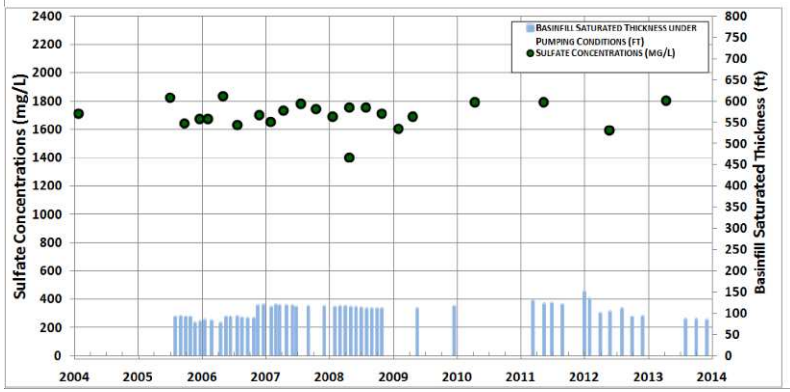
VERSION DATE: DECEMBER 15, 2013

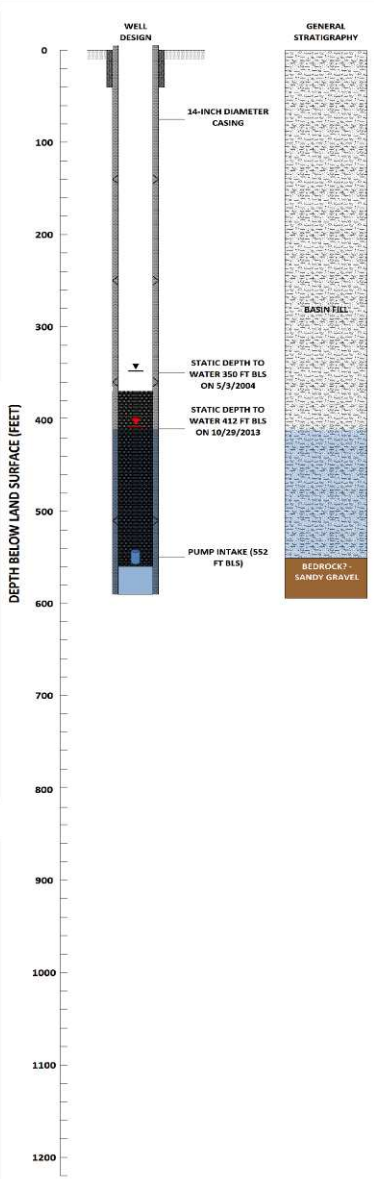
CADASTRAL: D-18-13 21CBC
ADWR REG. NO.: 55-508237
DRILL YEAR: 1984

BasinWells ASSOCIATES PLLC
WestLand Resources, Inc.
Engineering and Environmental Consultants









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SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

IW-22: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 21CBC
ADWR REG. NO.: 55-200554
DRILL YEAR: 2004

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WestLand Resources, Inc.
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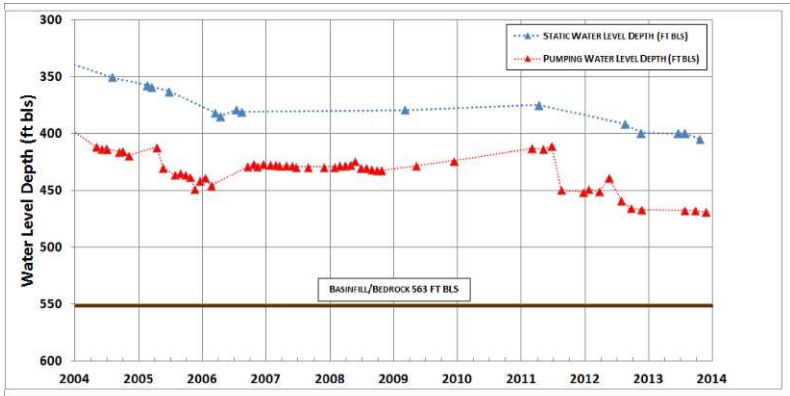
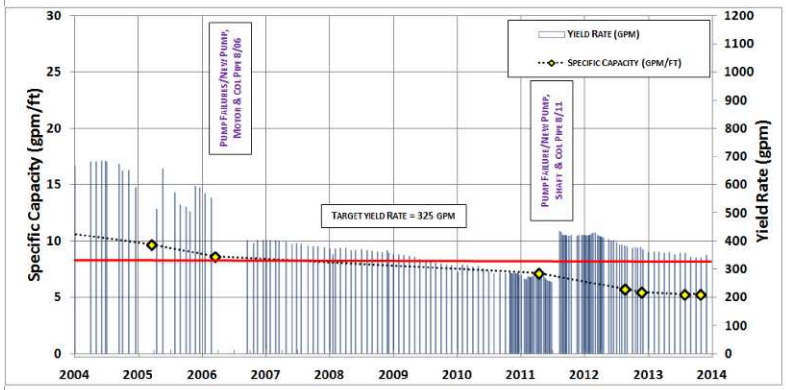
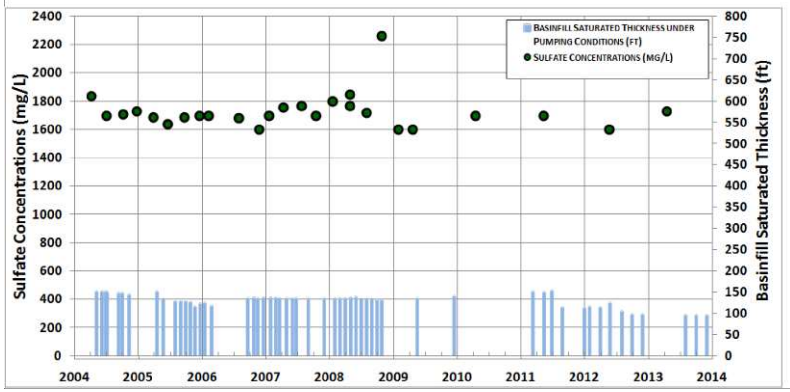
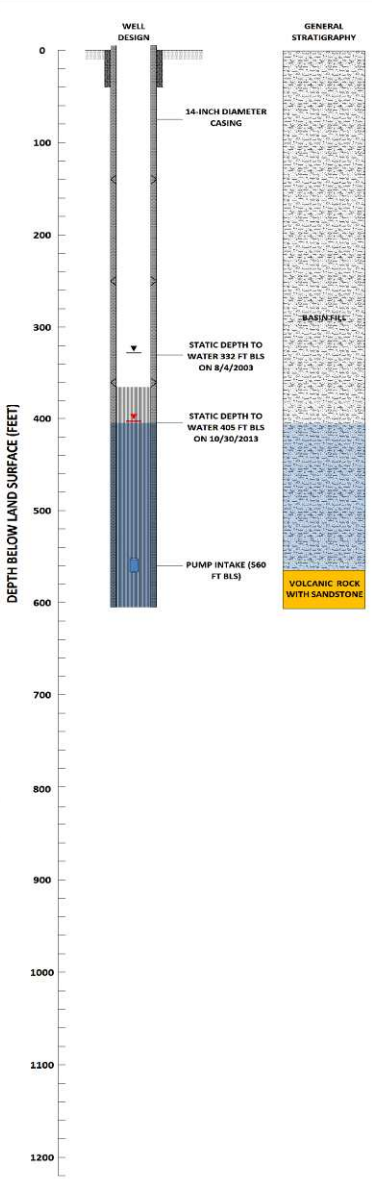
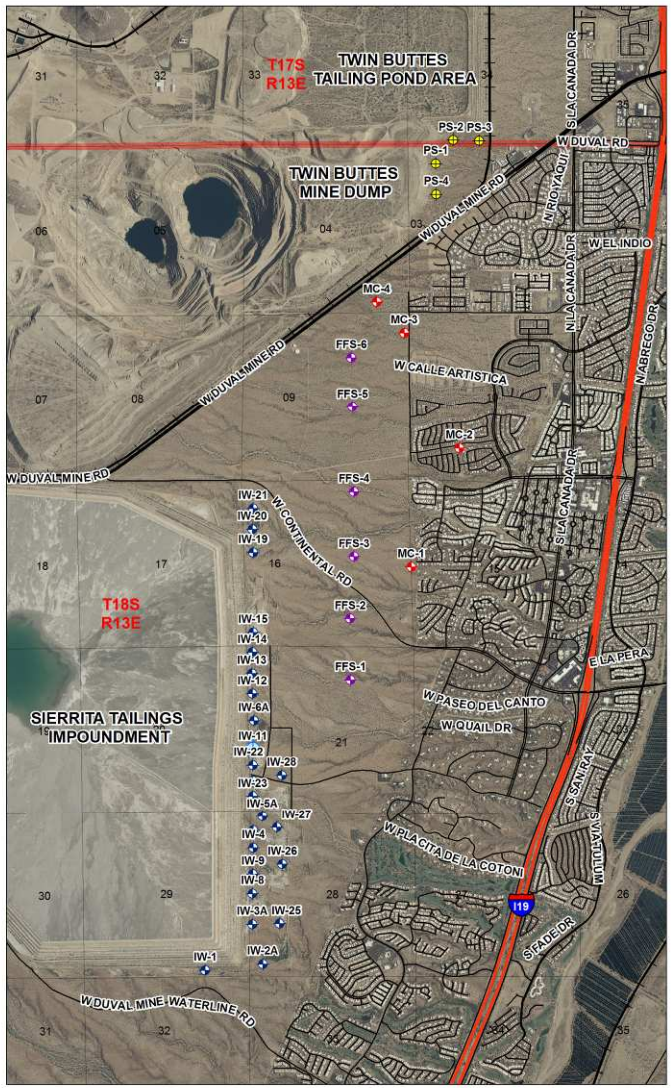


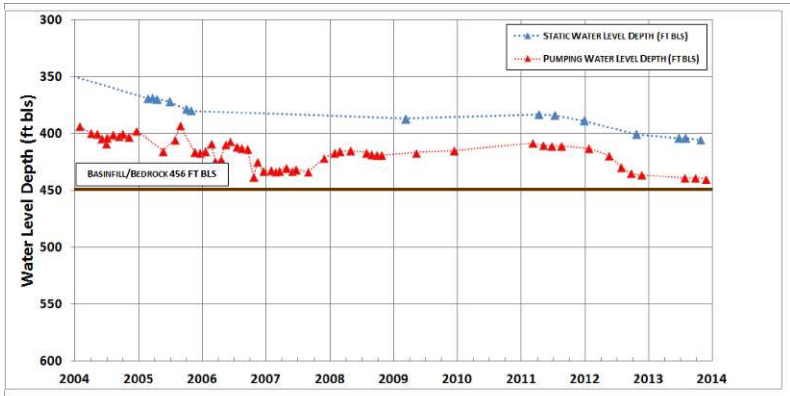


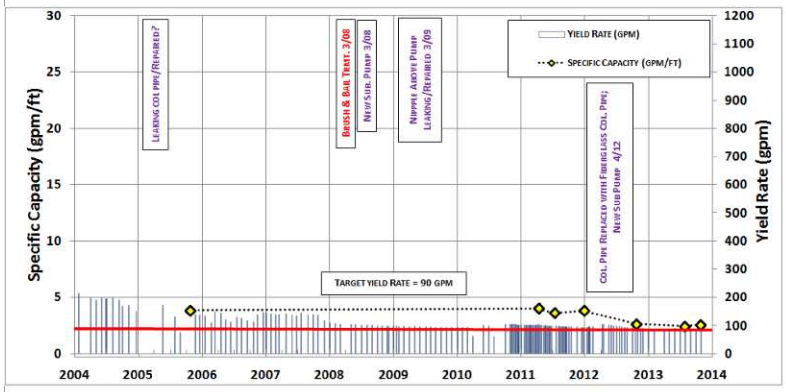


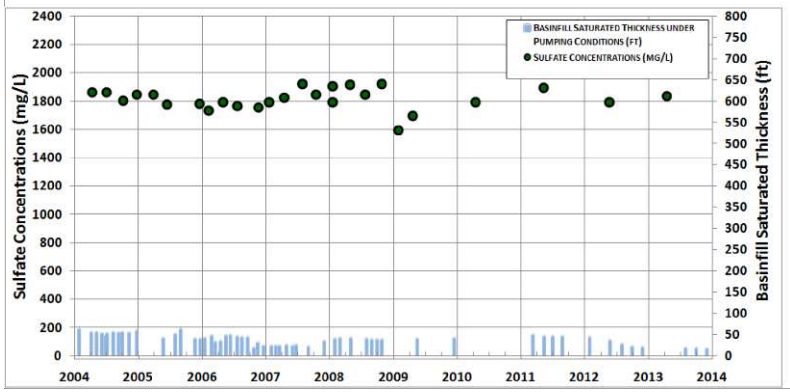


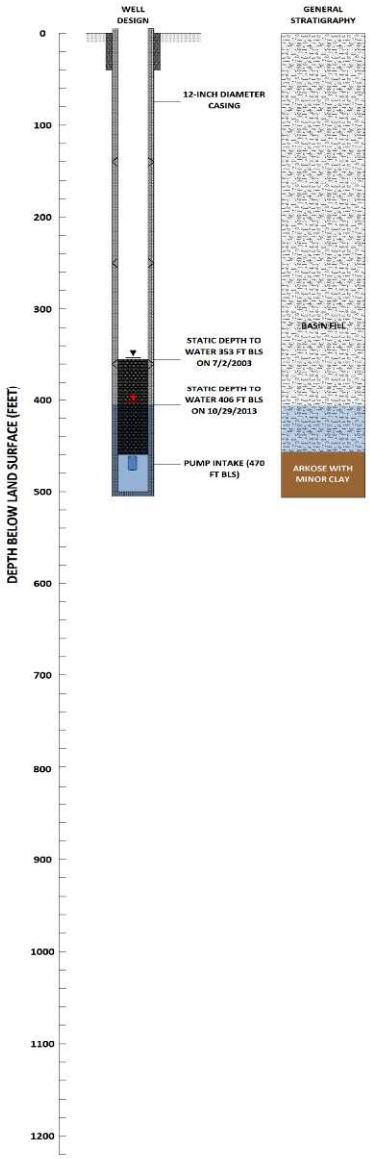


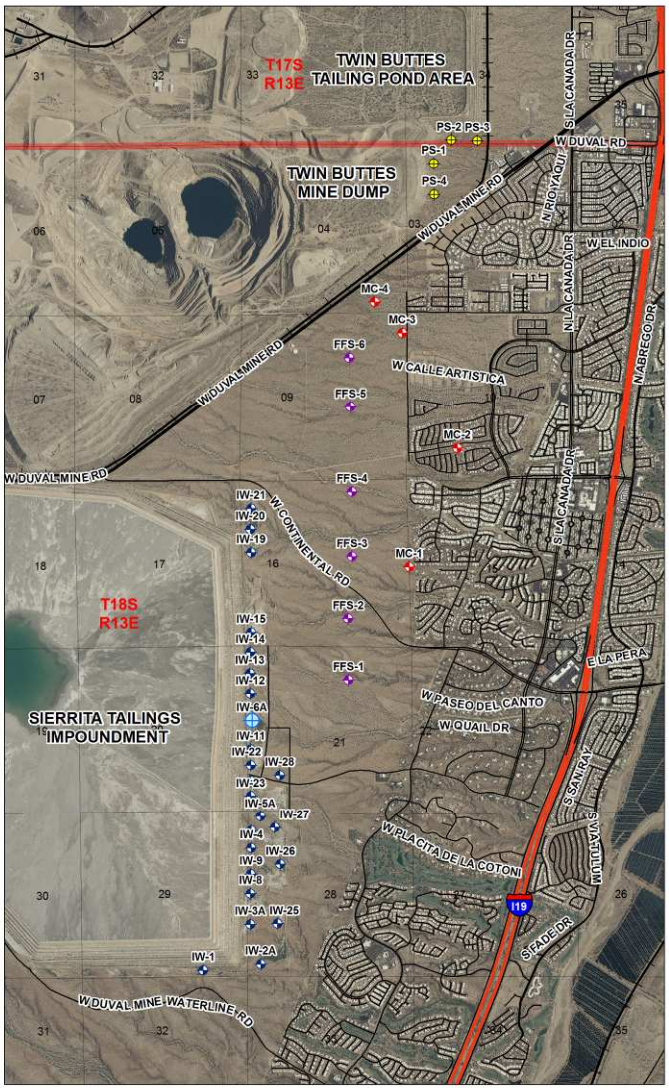
BasinWells ASSOCIATES PLLC	FREEPORT-McMoRan COPPER & GOLD	IW-11: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE
	VERSION DATE: DECEMBER 15, 2013	CADASTRAL: D-18-13 21CBC ADWR REG. NO.: 55-508235 DRILL YEAR: 1984











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FREEPORT-McMoRan COPPER & GOLD

IW-6A: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 21BCC
ADWR REG. NO.: 55-545565
DRILL YEAR: 1994

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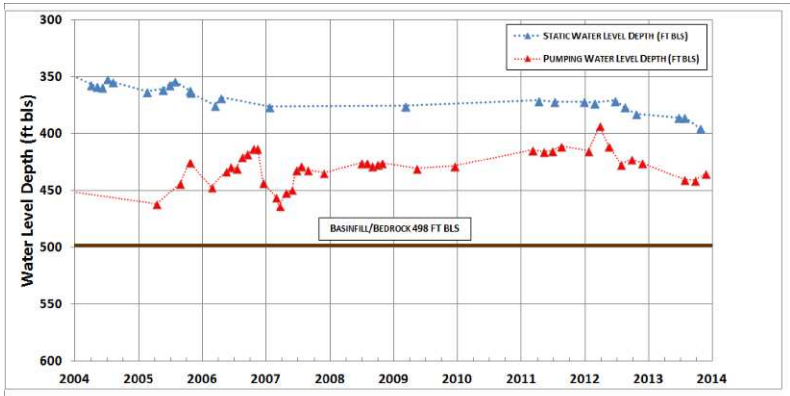
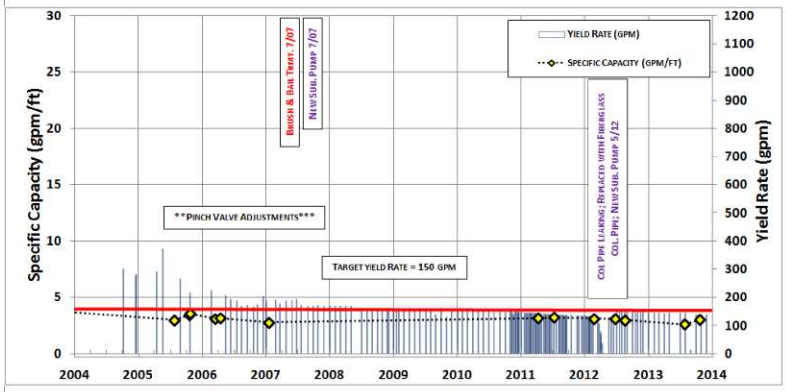
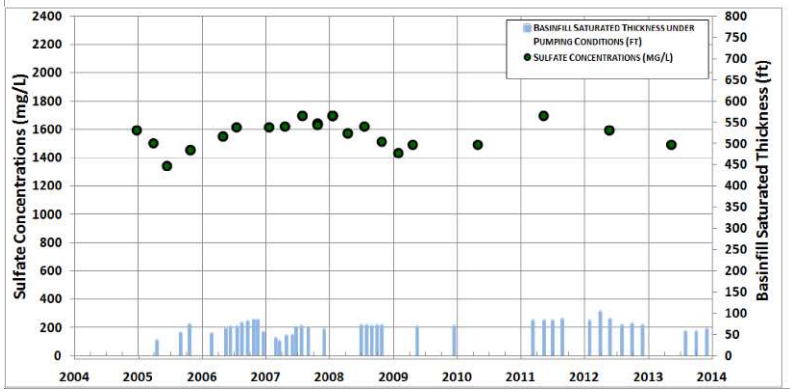
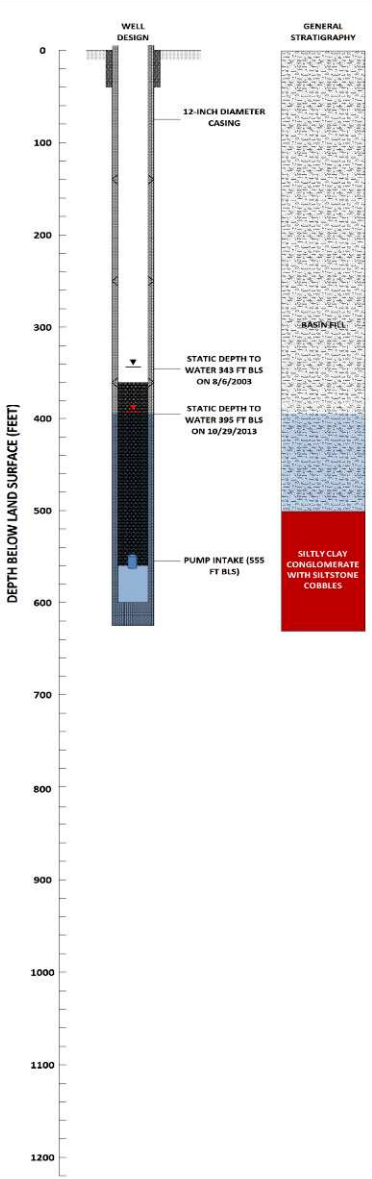
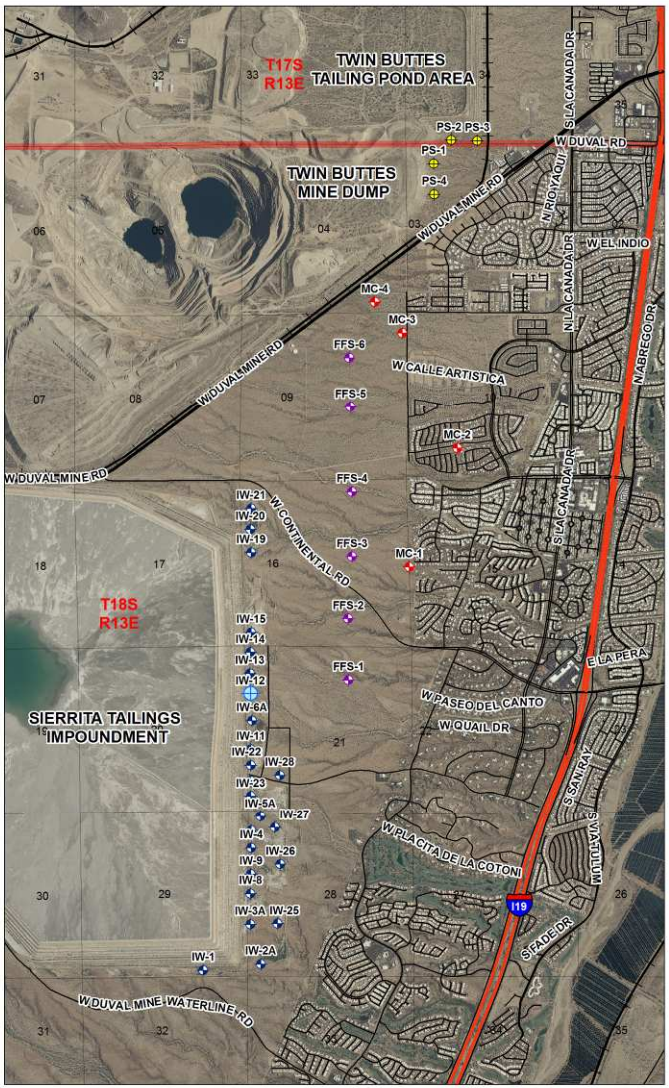










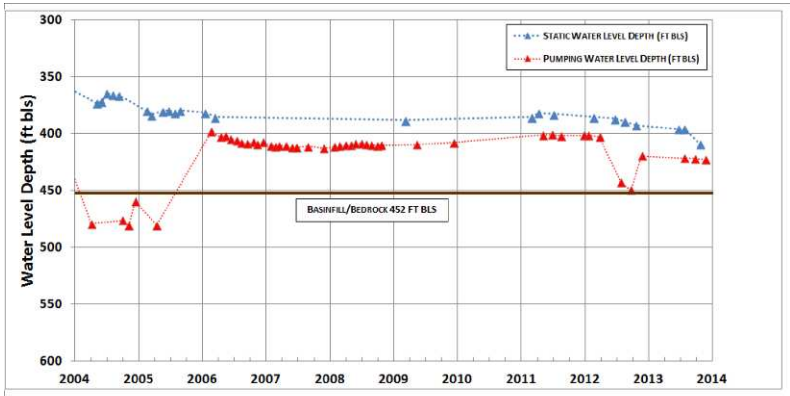
BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

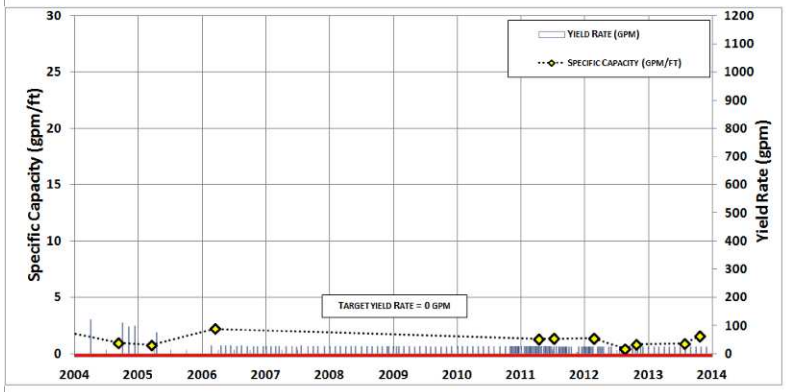
FREEPORT-MCMORAN COPPER & GOLD

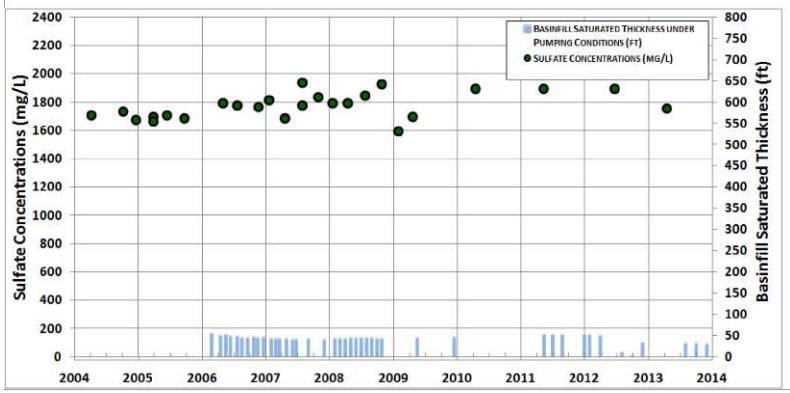
IW-12: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

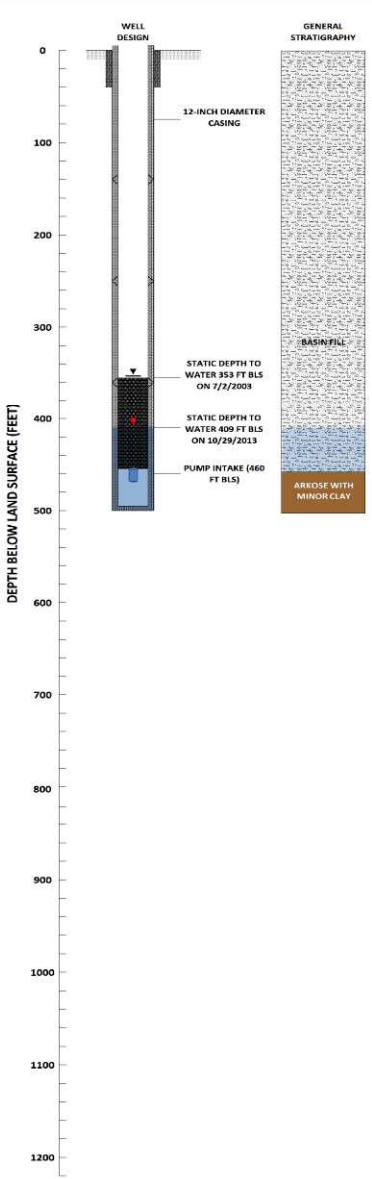
VERSION DATE: DECEMBER 15, 2013

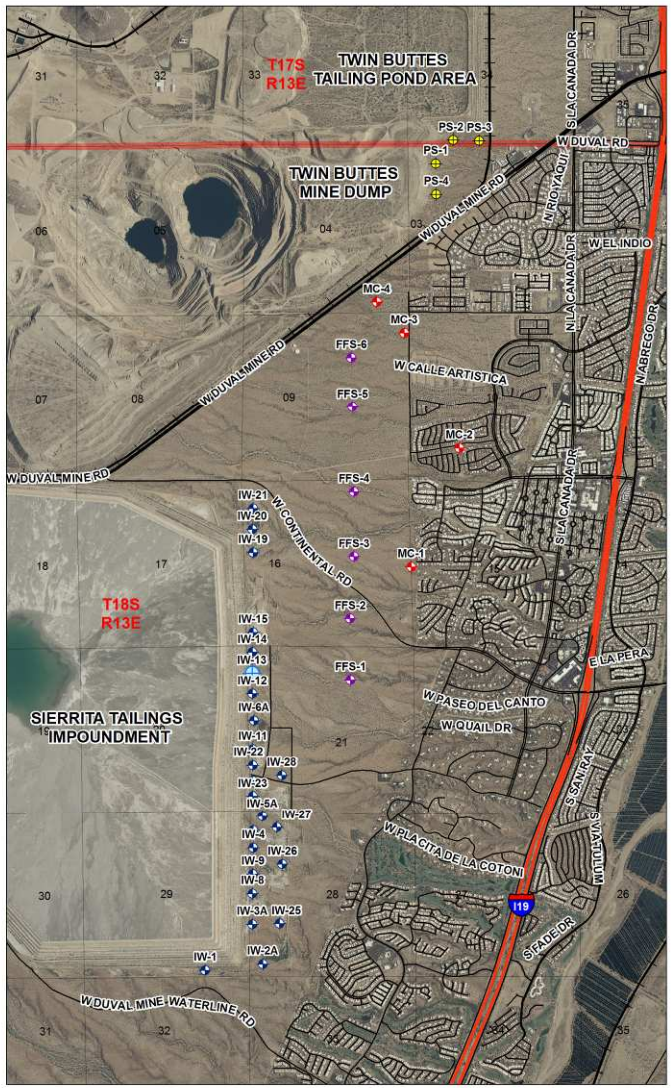
CADASTRAL: D-18-13 21BCB
ADWR REG. NO.: 55-545555
DRILL YEAR: 1994











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FREEPORT-McMoRan COPPER & GOLD

IW-13: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 21BBC
ADWR REG. NO.: 55-545556
DRILL YEAR: 1994

BasinWells ASSOCIATES PLLC
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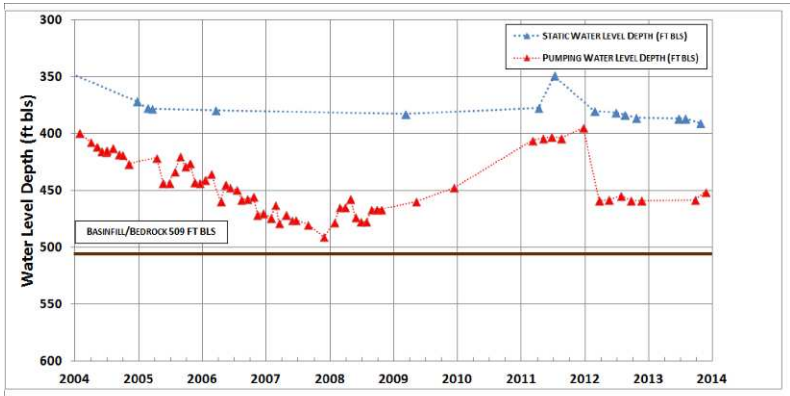

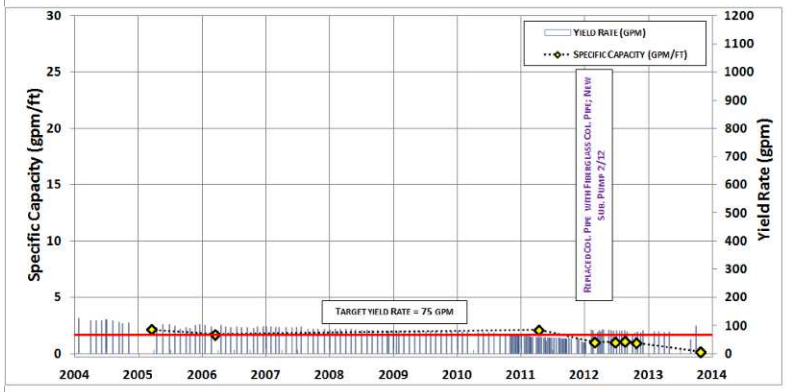

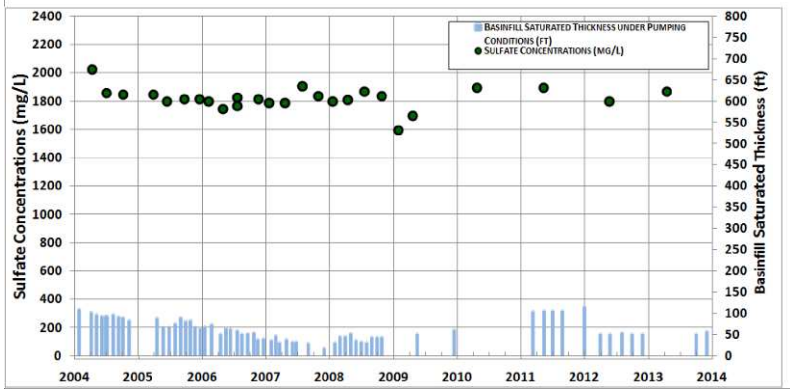

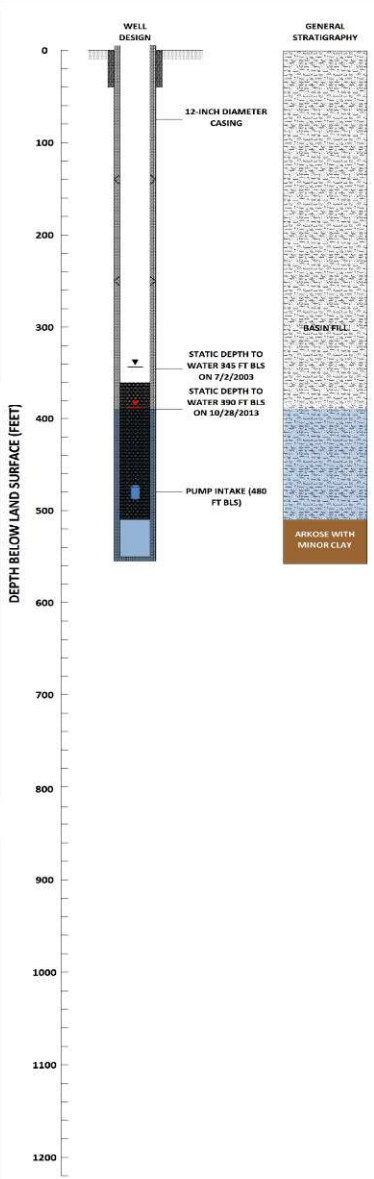

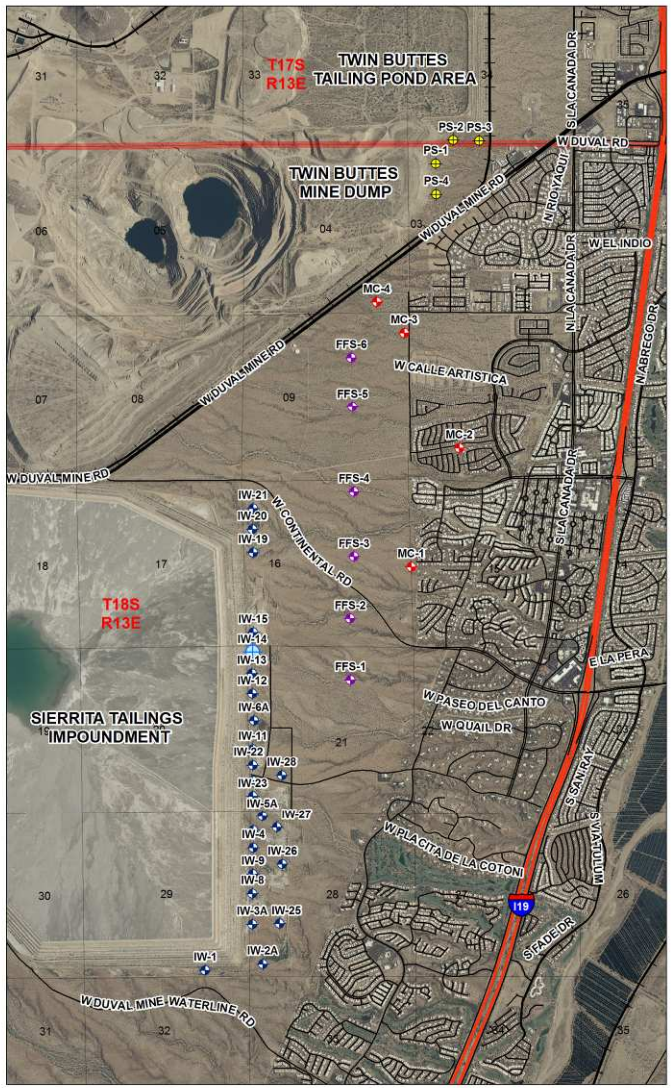

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SPECIALISTS IN GROUNDWATER DEVELOPMENT

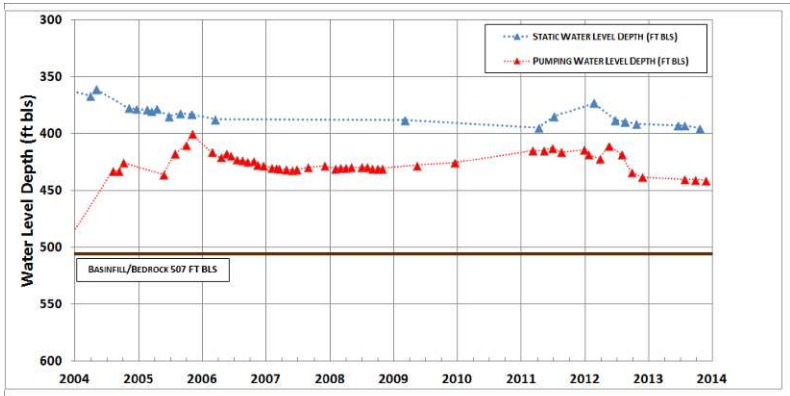
FREEPORT-MCMORAN COPPER & GOLD

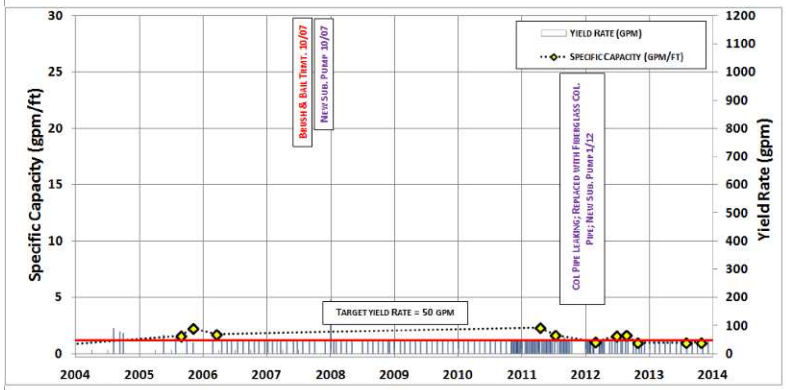
IW-14: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

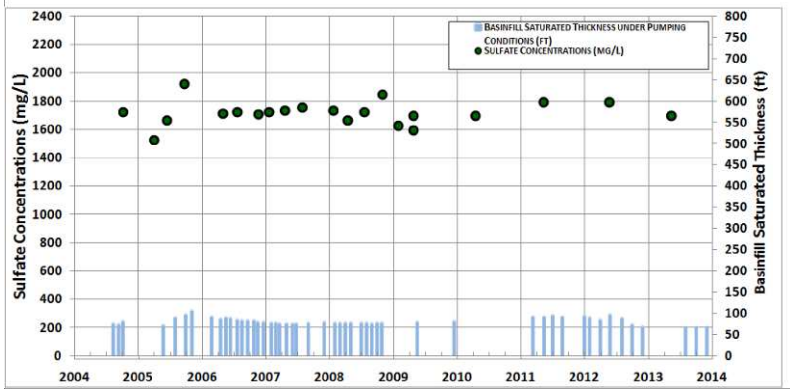
VERSION DATE: DECEMBER 15, 2013

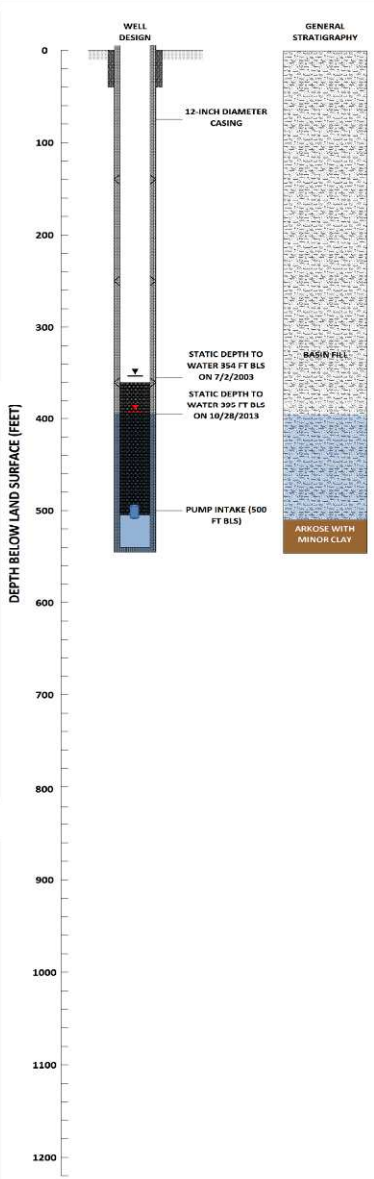
CADASTRAL: D-18-13 21BBB
ADWR REG. NO.: 55-545557
DRILL YEAR: 1994

BasinWells ASSOCIATES PLLC
WestLand Resources, Inc.
Engineering and Environmental Consultants









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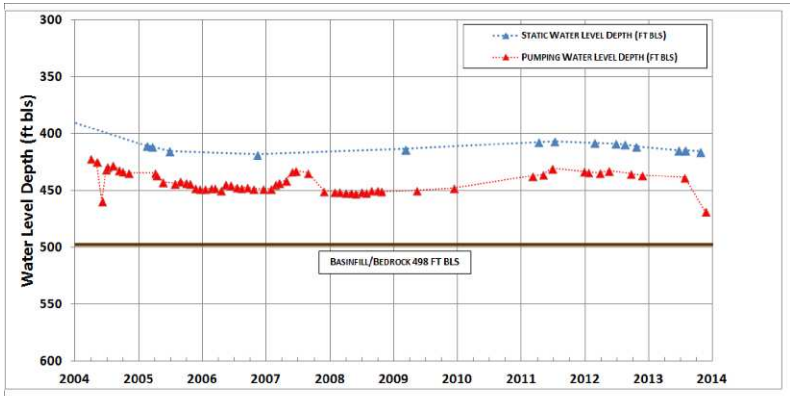
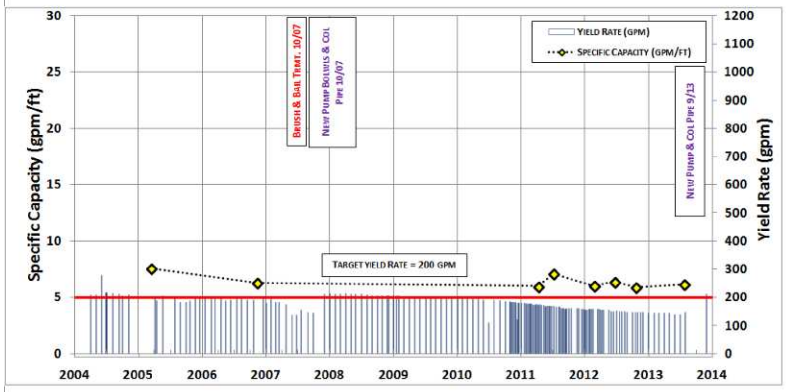
FREEPORT-McMoRan COPPER & GOLD

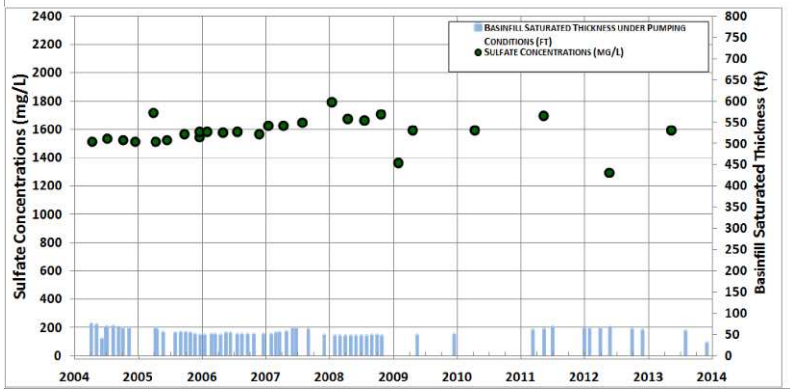
IW-15: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

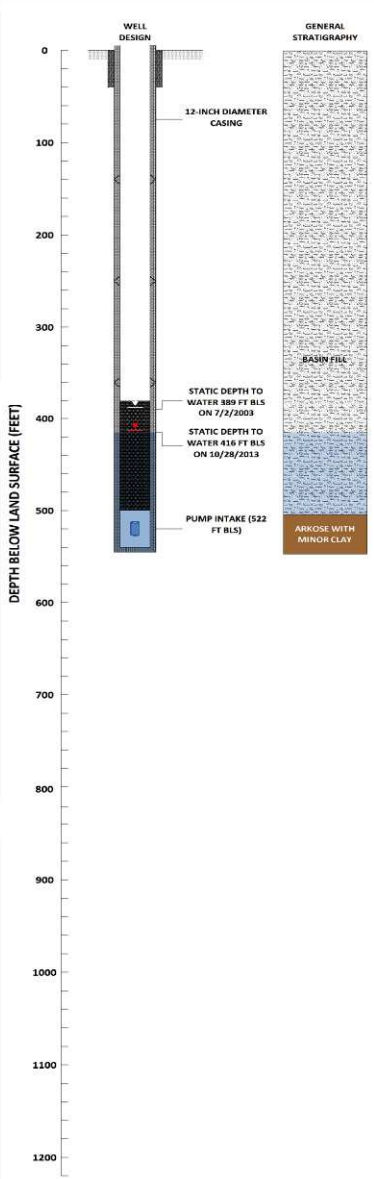
VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 16CCC
ADWR REG. NO.: 55-545558
DRILL YEAR: 1995









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SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-MCMORAN COPPER & GOLD

IW-19: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 16BCC
ADWR REG. NO.: 55-545562
DRILL YEAR: 1995

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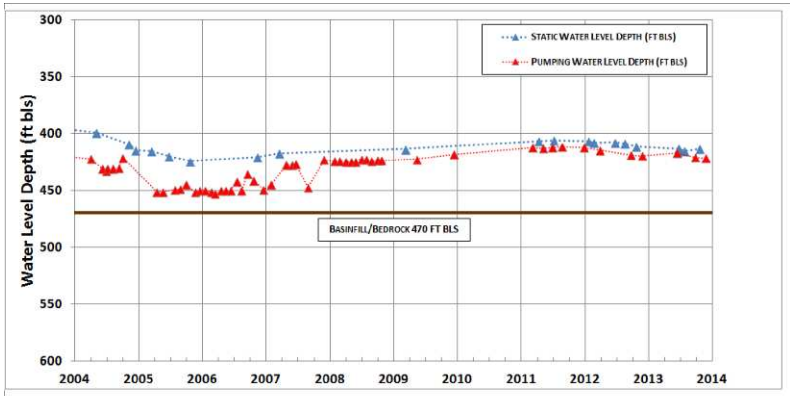
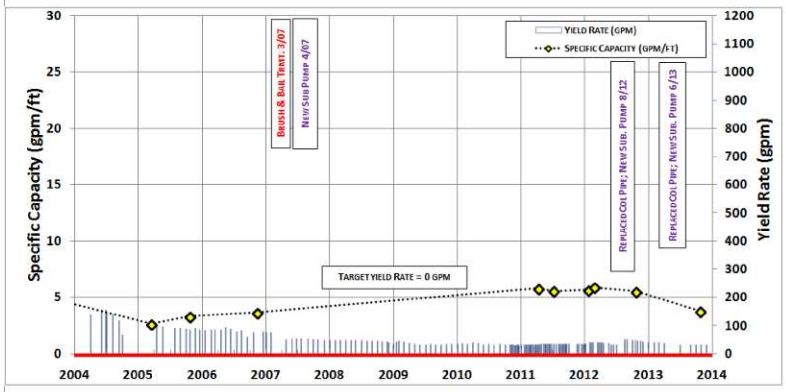
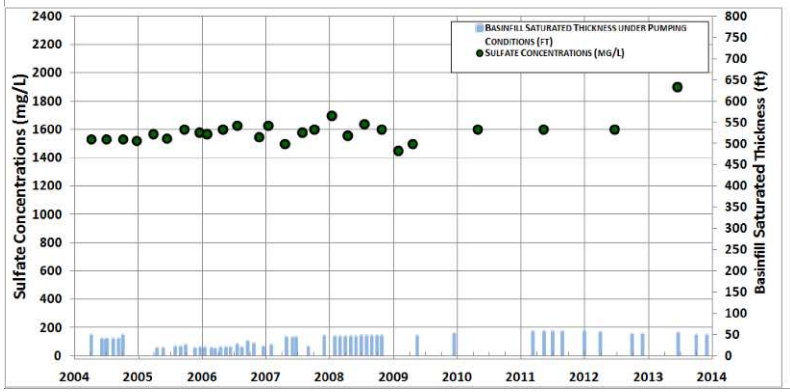
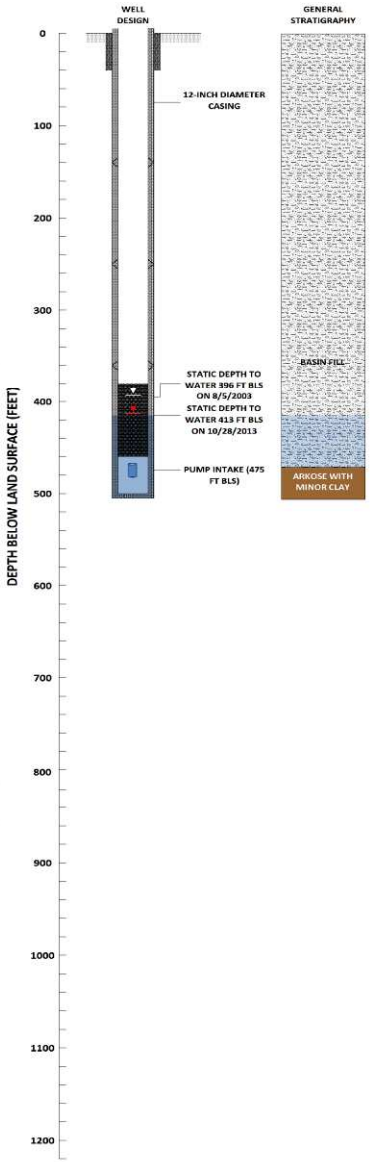
Engineering and Environmental Consultants









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IW-20: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 16BCB
ADWR REG. NO.: 55-545563
DRILL YEAR: 1995

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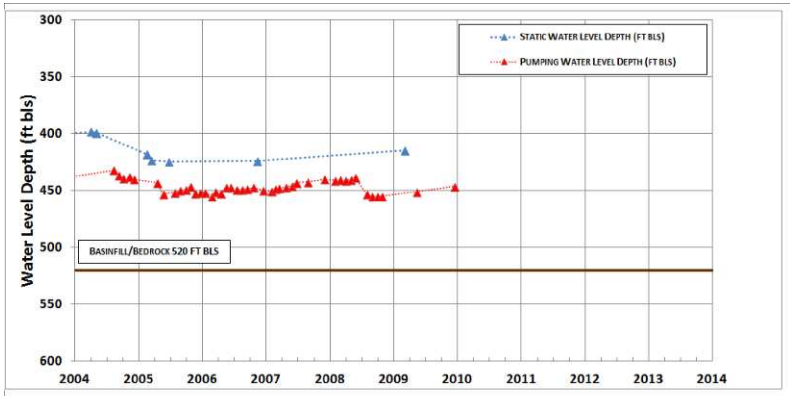

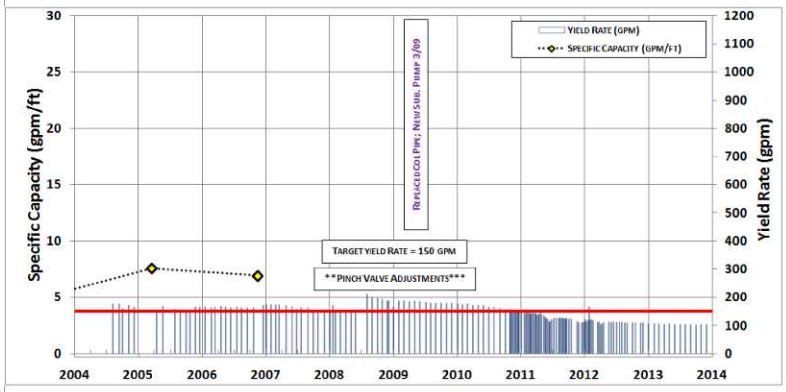

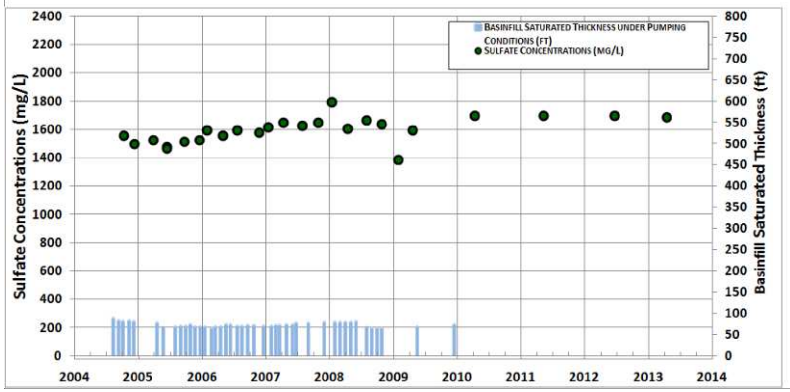

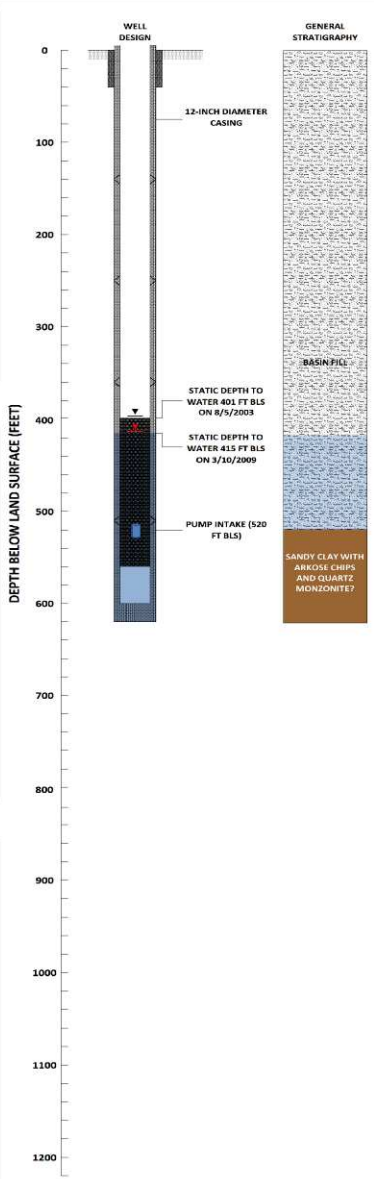

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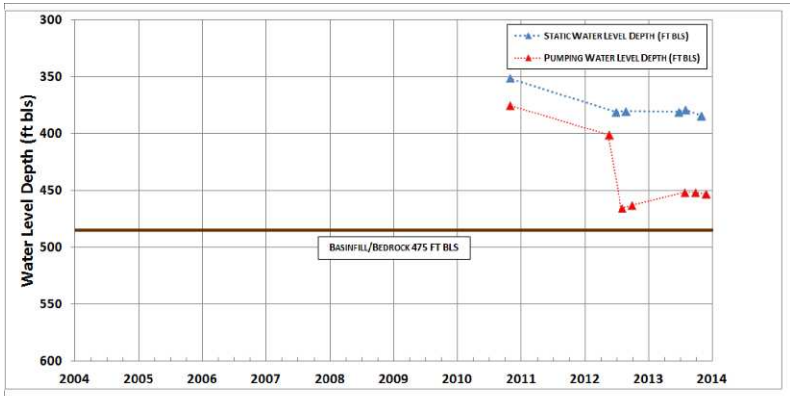
SPECIALISTS IN GROUNDWATER DEVELOPMENT

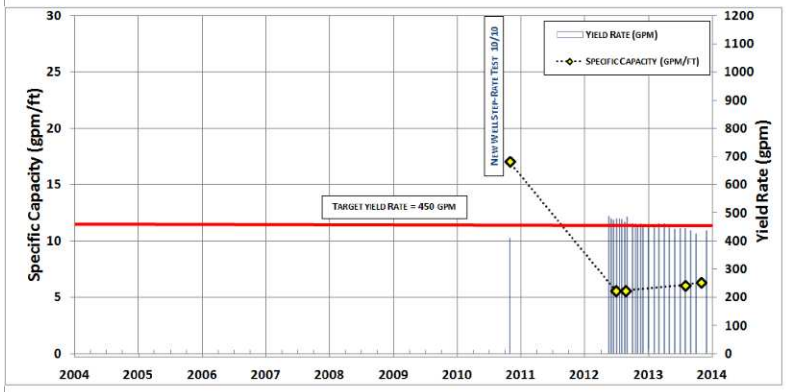
FREEPORT-McMoRan COPPER & GOLD

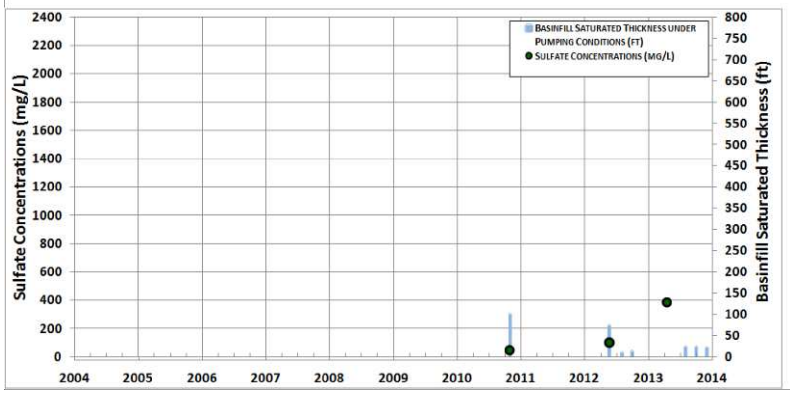
IW-21: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

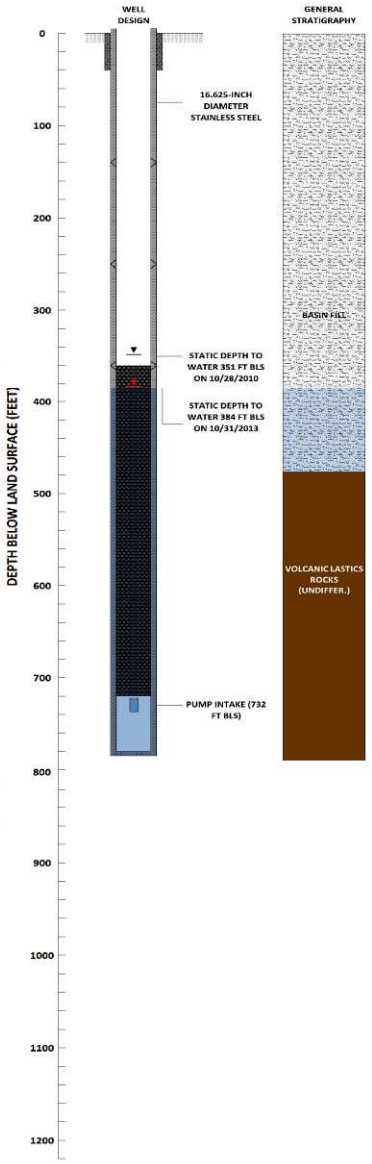
VERSION DATE: DECEMBER 15, 2013

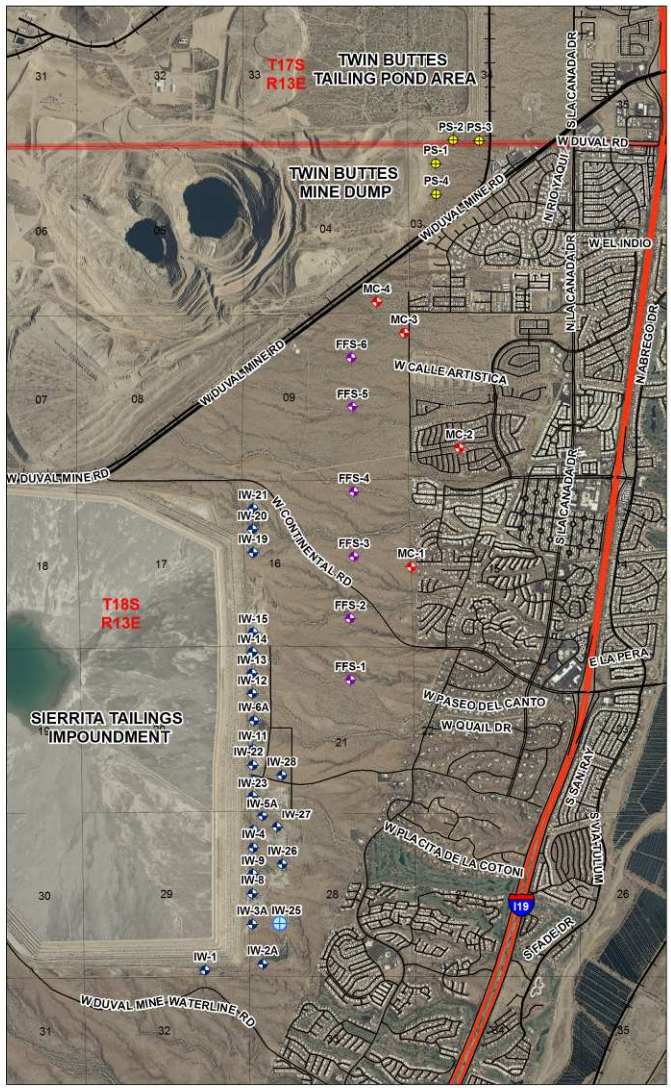
CADASTRAL: D-18-13 16BBC
ADWR REG. NO.: 55-545564
DRILL YEAR: 1995











BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

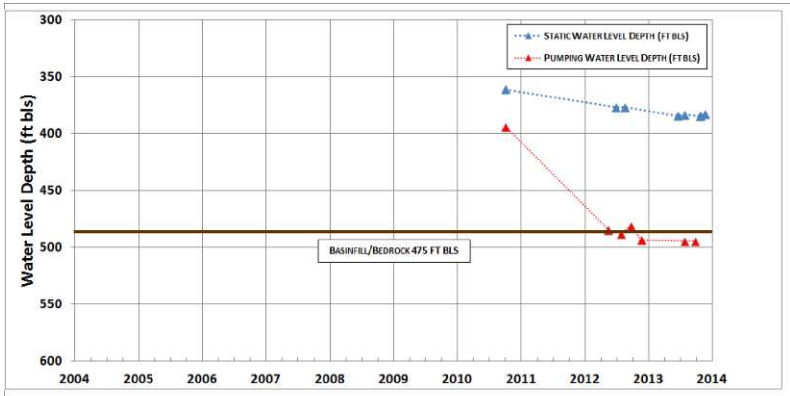
FREEPORT-MCMORAN COPPER & GOLD

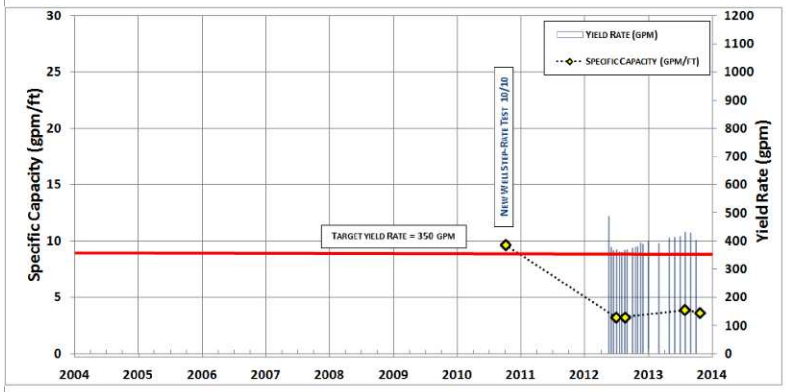
IW-25: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

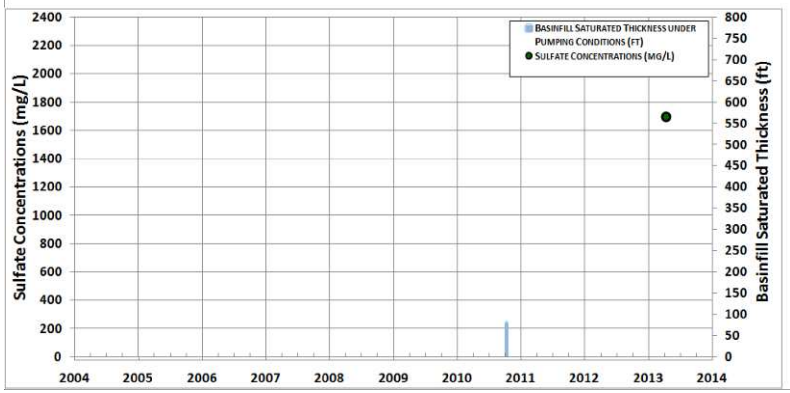
VERSION DATE: DECEMBER 15, 2013

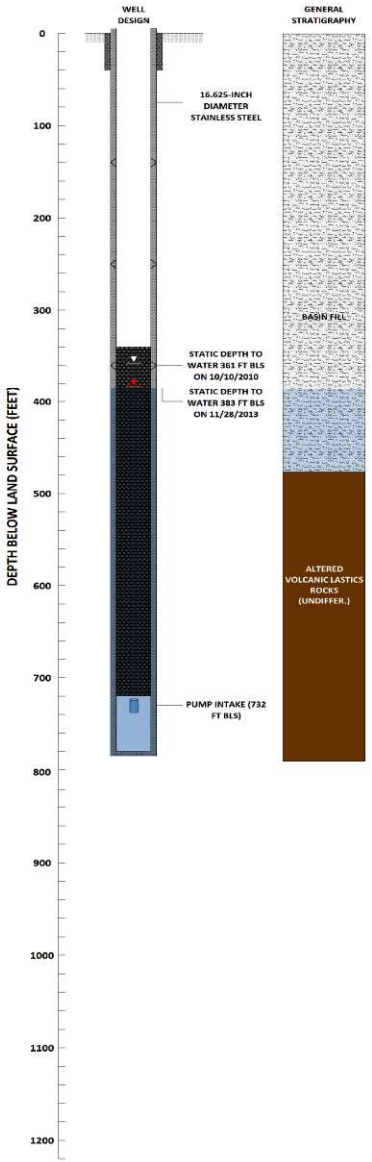
CADASTRAL: D-18-13 28CBD
ADWR REG. NO.: 55-219596
DRILL YEAR: 2010

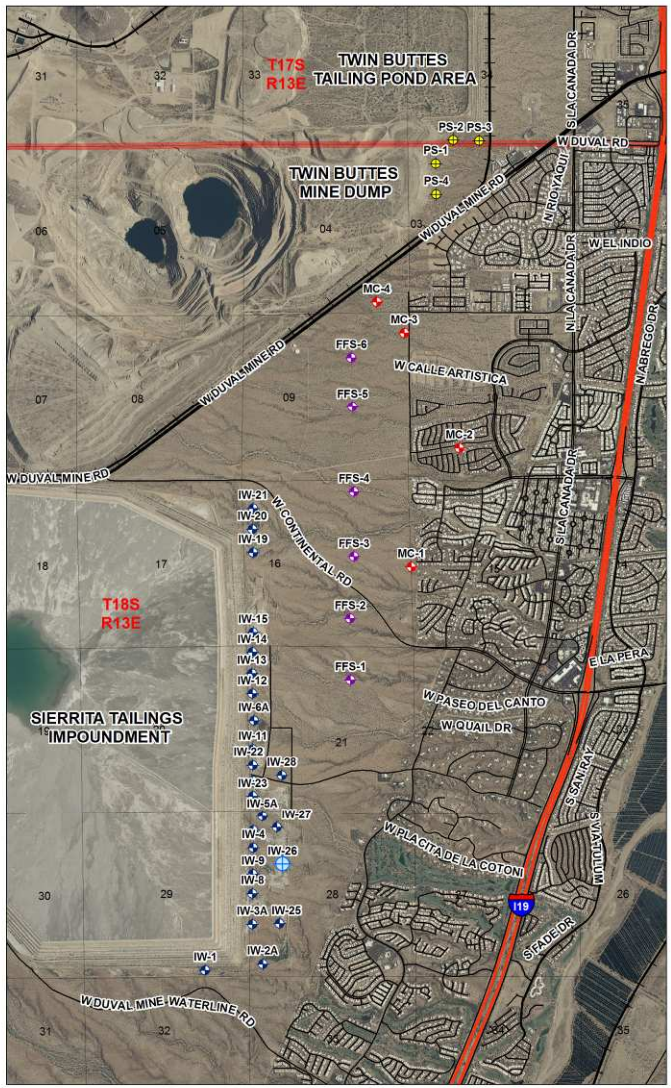
BasinWells ASSOCIATES PLLC
WestLand Resources, Inc.
Engineering and Environmental Consultants











BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-MCMORAN COPPER & GOLD

IW-26: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 28BCD
ADWR REG. NO.: 55-219143
DRILL YEAR: 2010

BasinWells ASSOCIATES PLLC
WestLand Resources, Inc.
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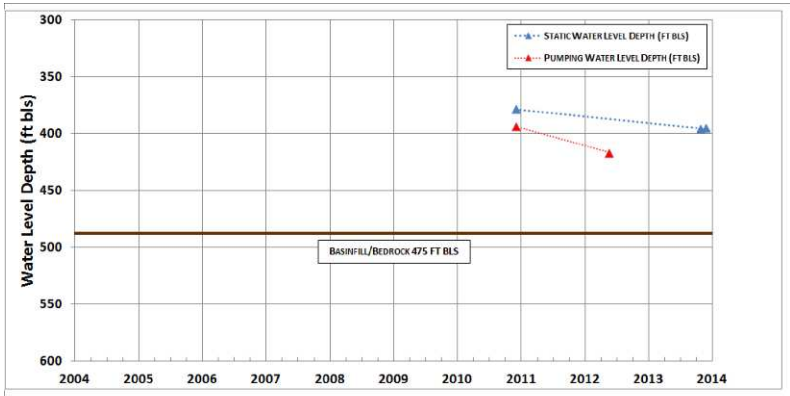

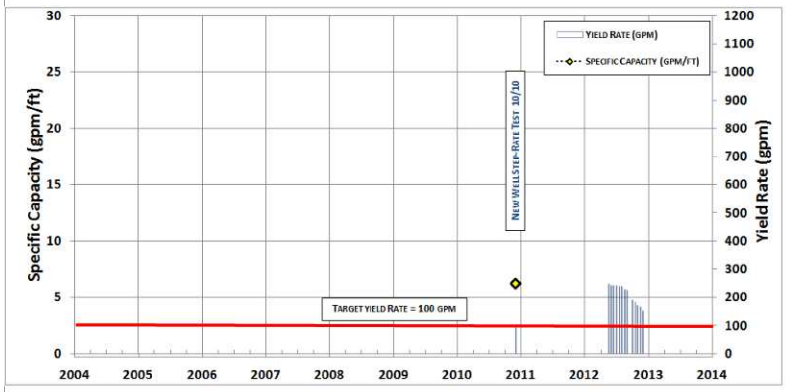

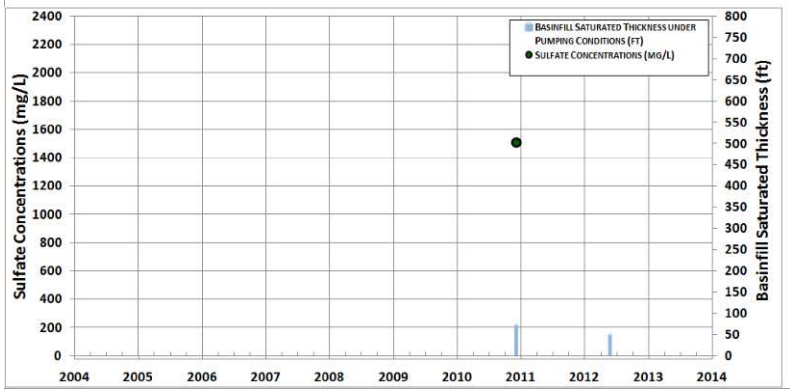

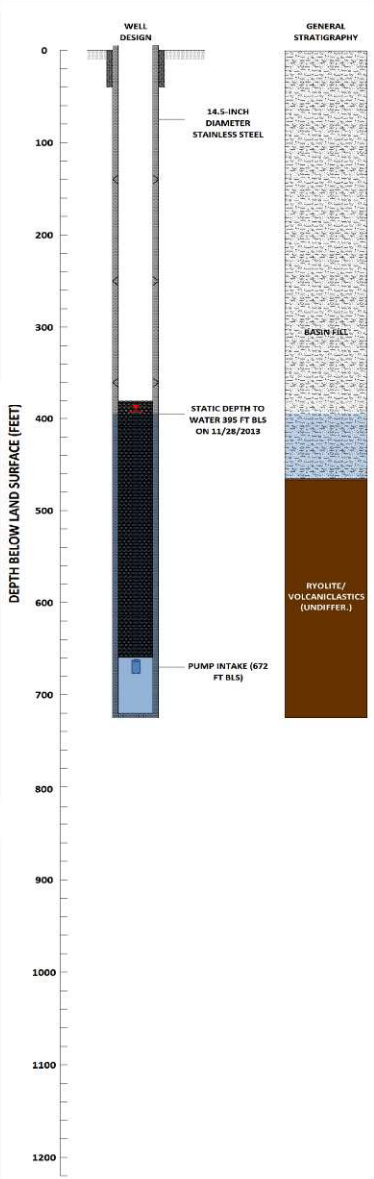

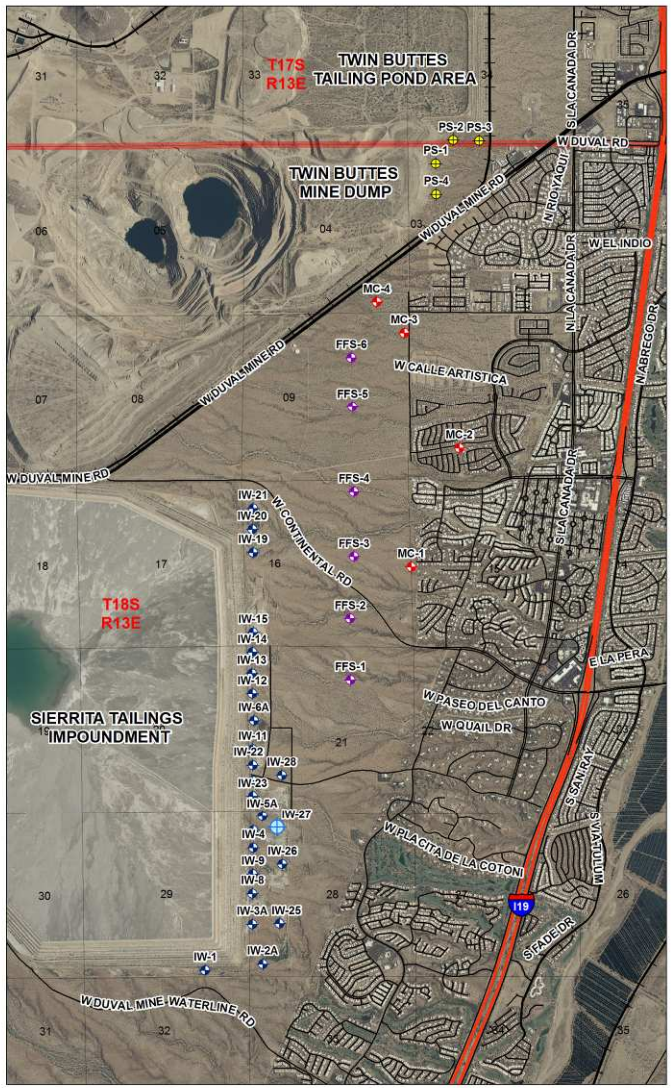

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FREEPORT-MCMORAN COPPER & GOLD

IW-27: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 28BBD
ADWR REG. NO.: 55-219136
DRILL YEAR: 2010

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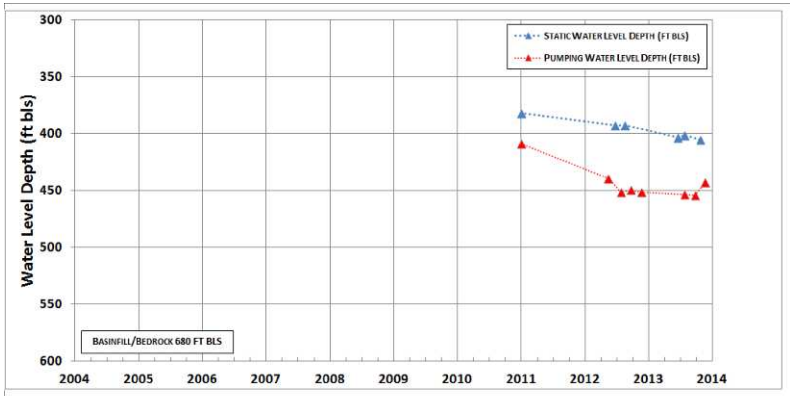
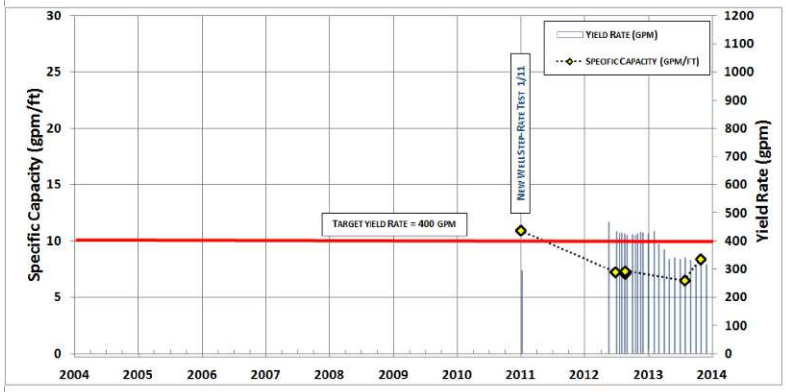
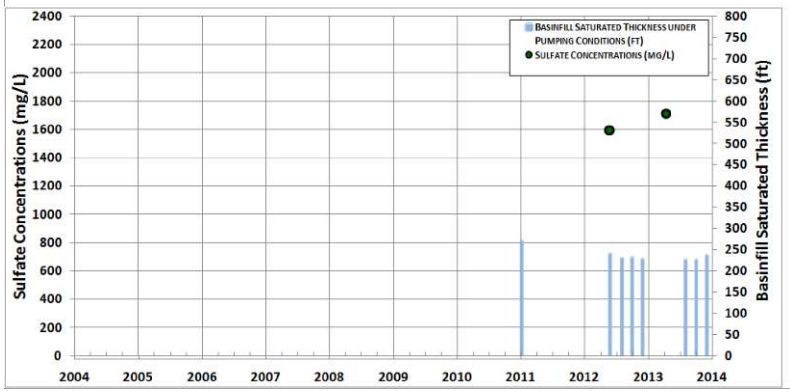
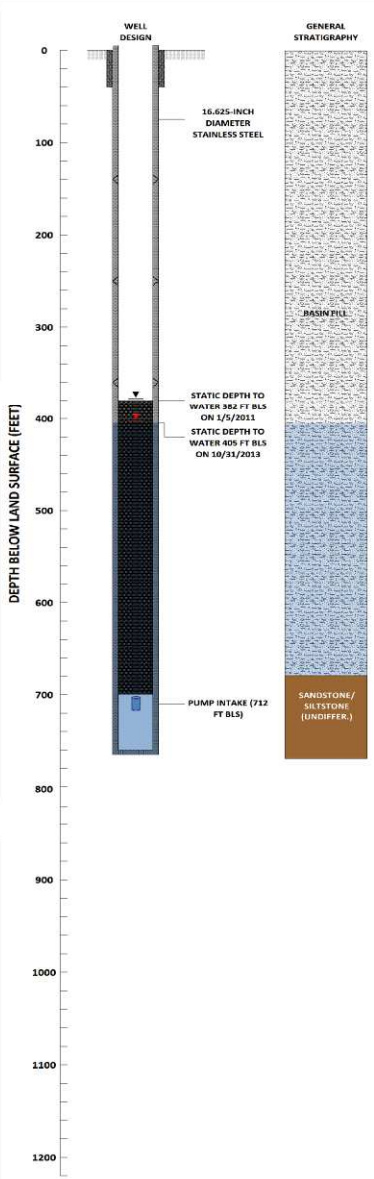
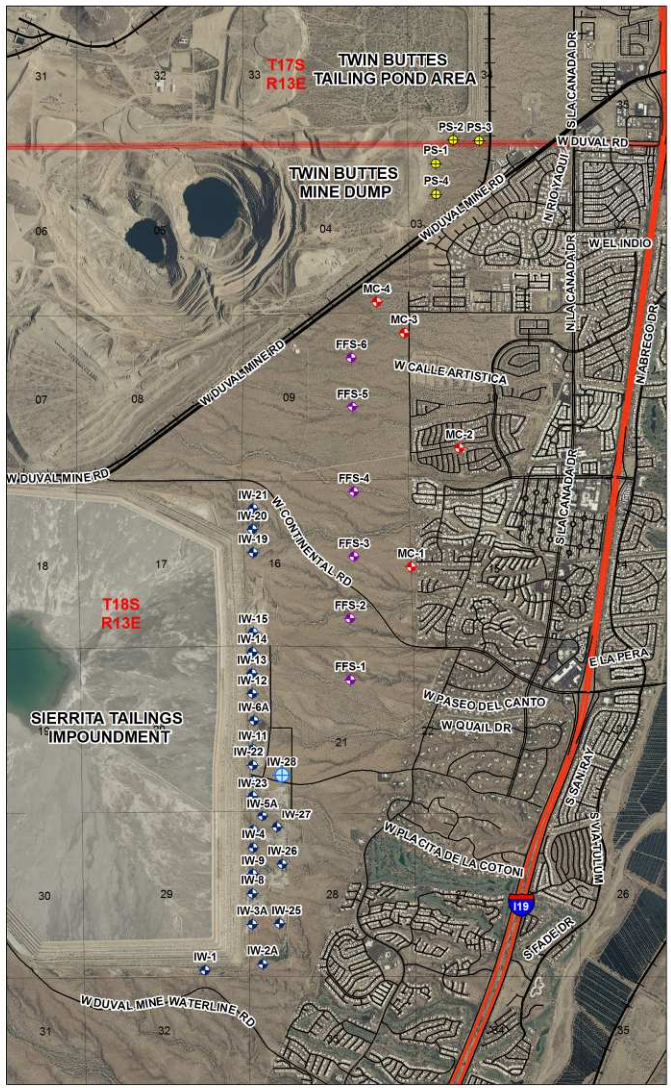


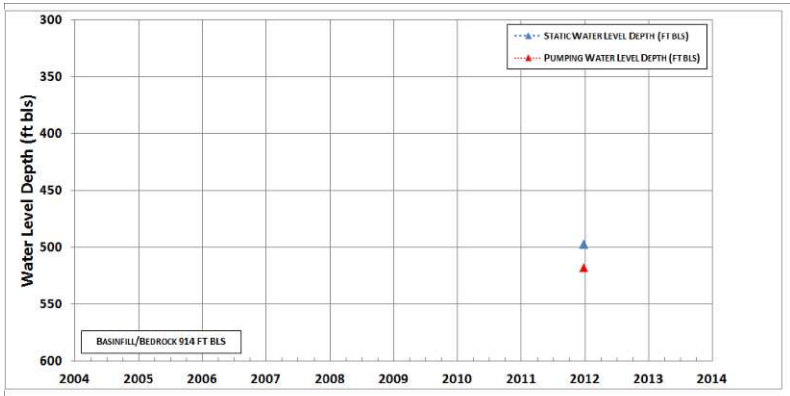


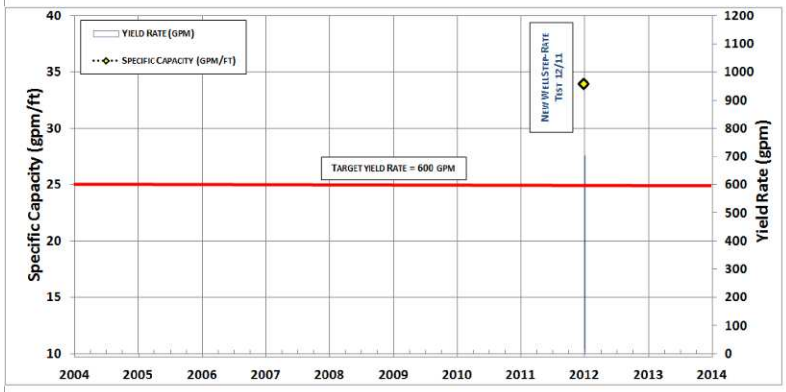


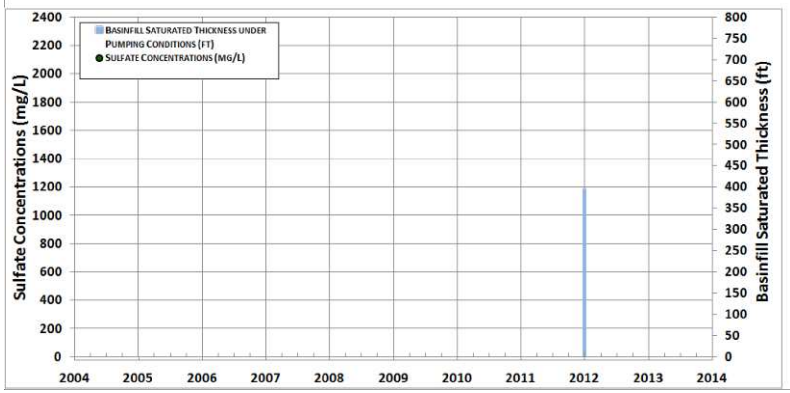


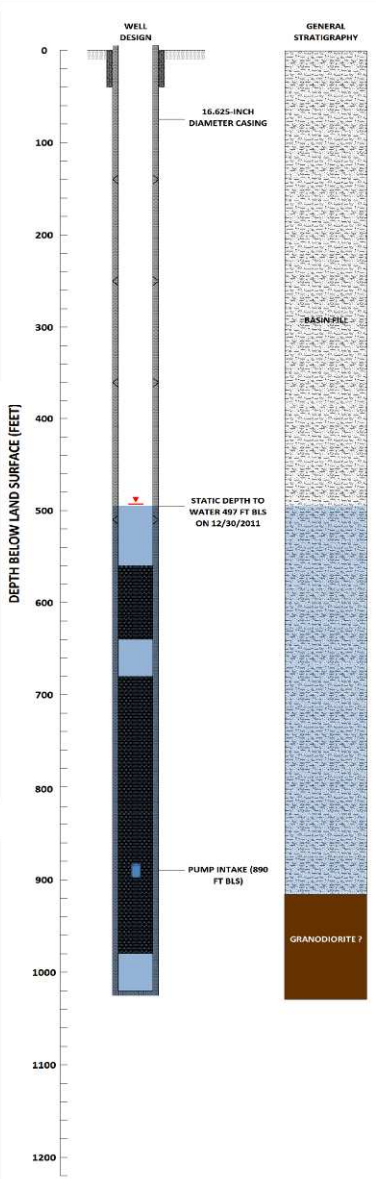


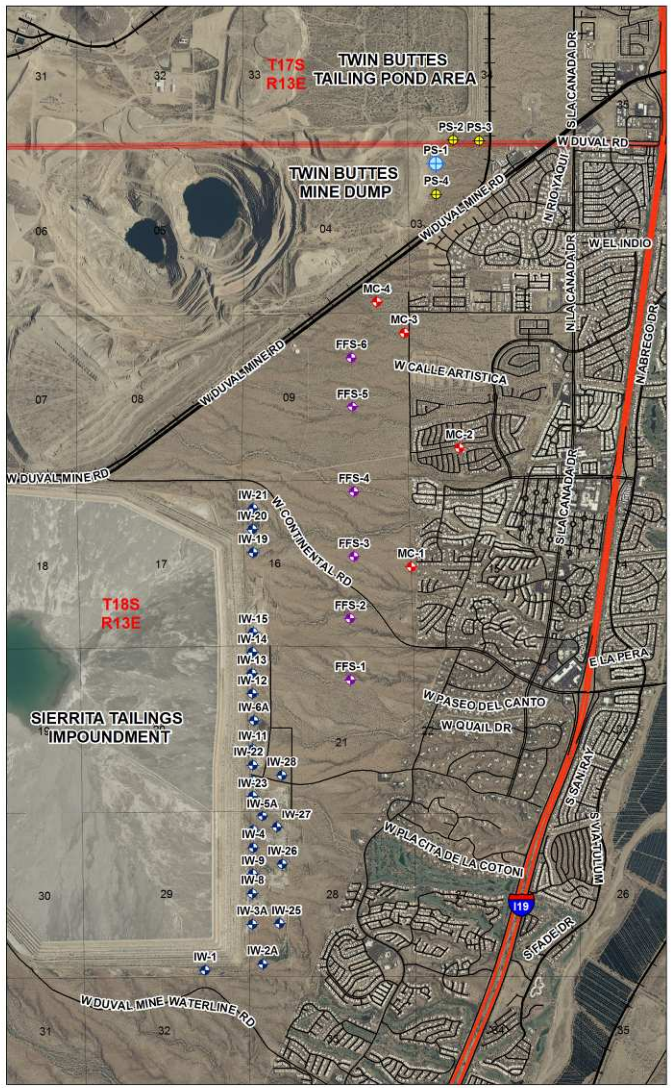
BasinWells ASSOCIATES PLLC	FREEPORT-MCMORAN COPPER & GOLD	IW-28: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE
	VERSION DATE: DECEMBER 15, 2013	CADASTRAL: D-18-13 21CCA ADWR REG. NO.: 55-219137 DRILL YEAR: 2010











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FREEPORT-MCMORAN COPPER & GOLD

PS-1: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 03BBA
ADWR REG. NO.: 55-220861
DRILL YEAR: 2011

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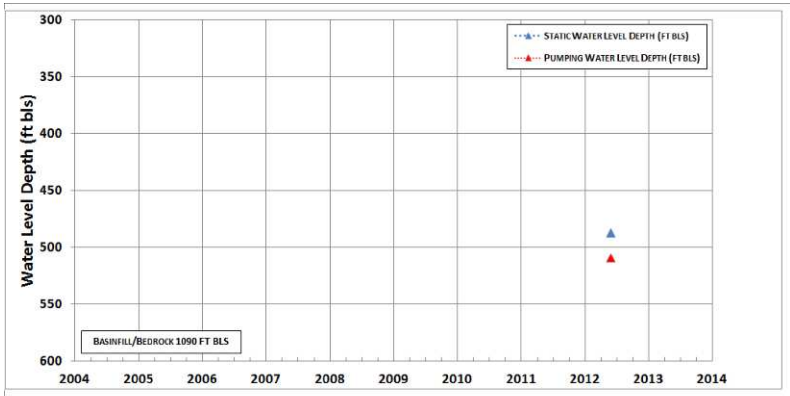

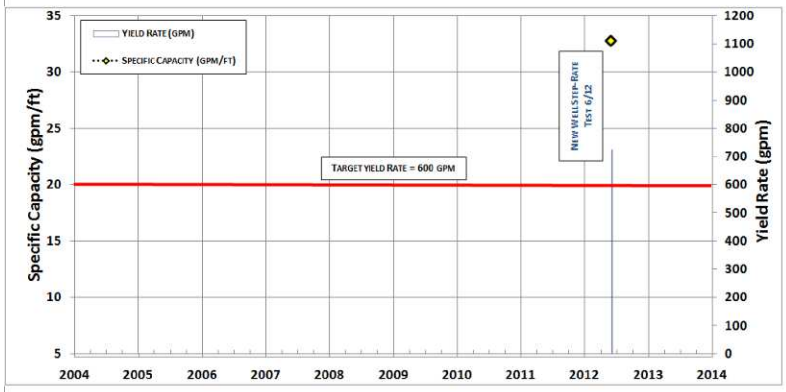

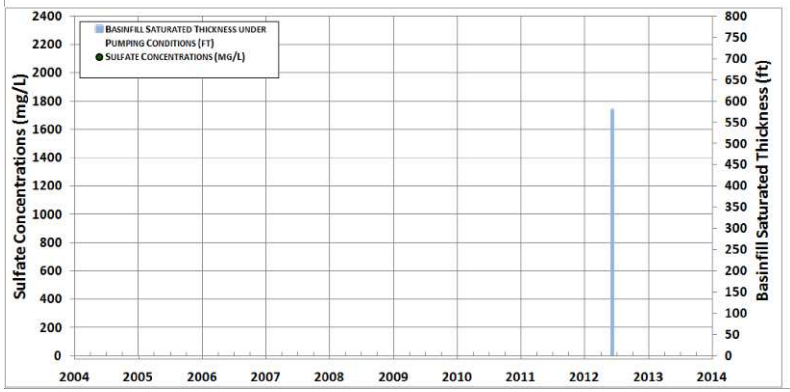

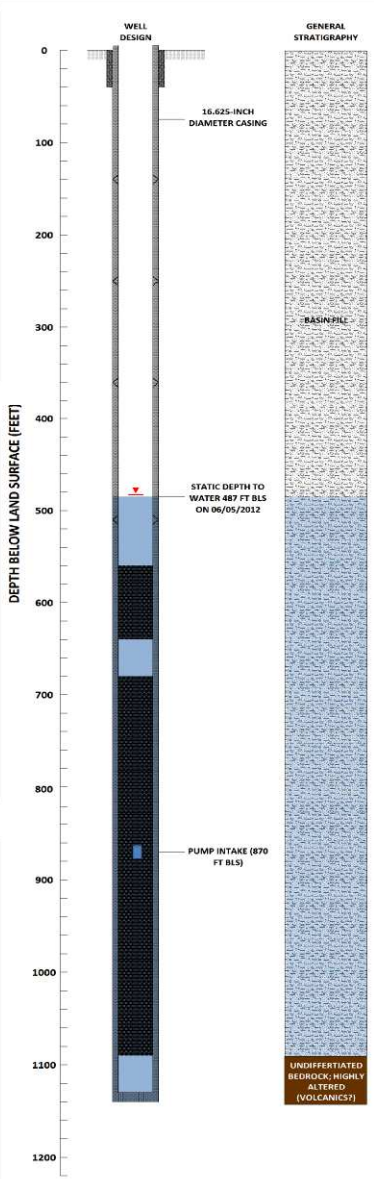

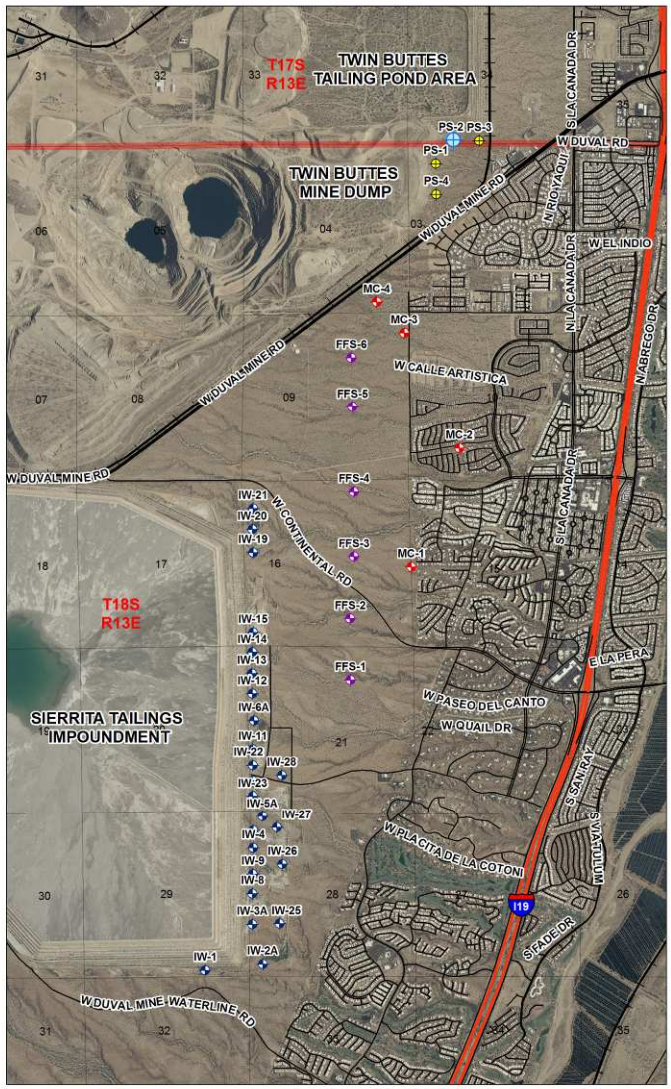

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FREEPORT-McMoRan COPPER & GOLD

PS-2: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-17-13 34CDC
ADWR REG. NO.: 55-220862
DRILL YEAR: 2012

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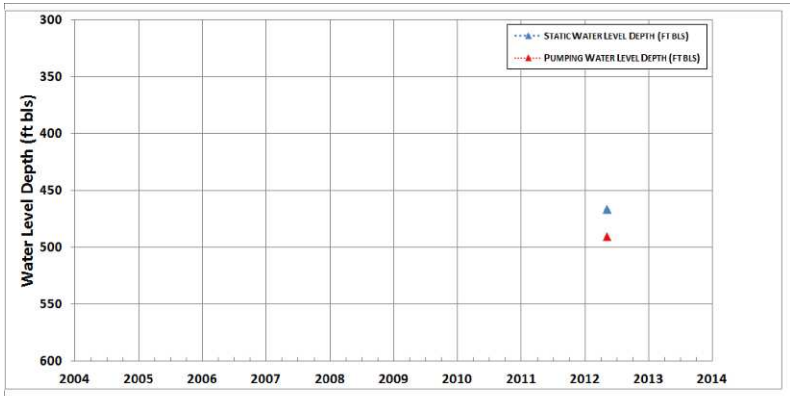
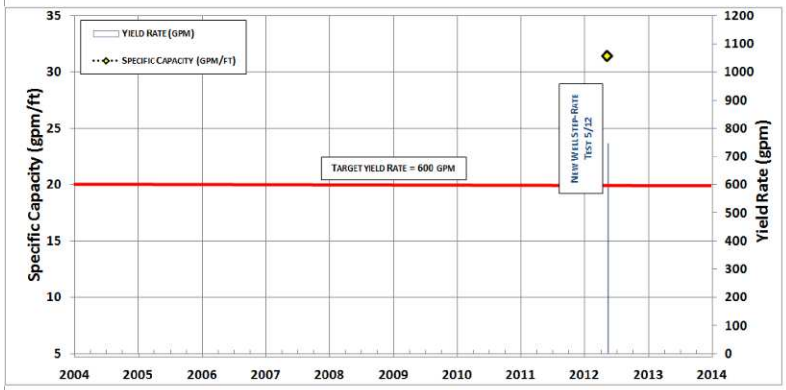
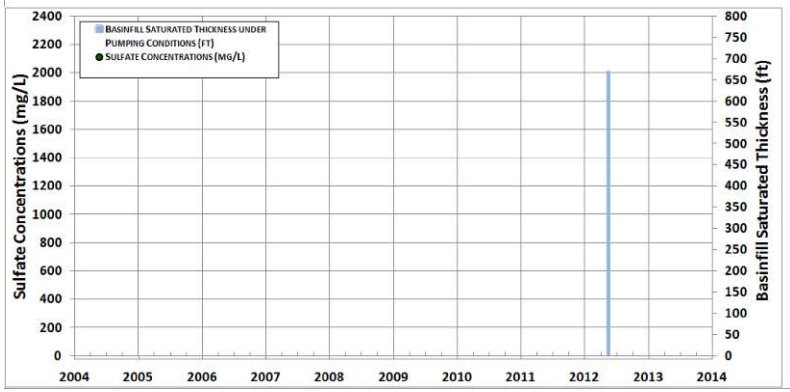
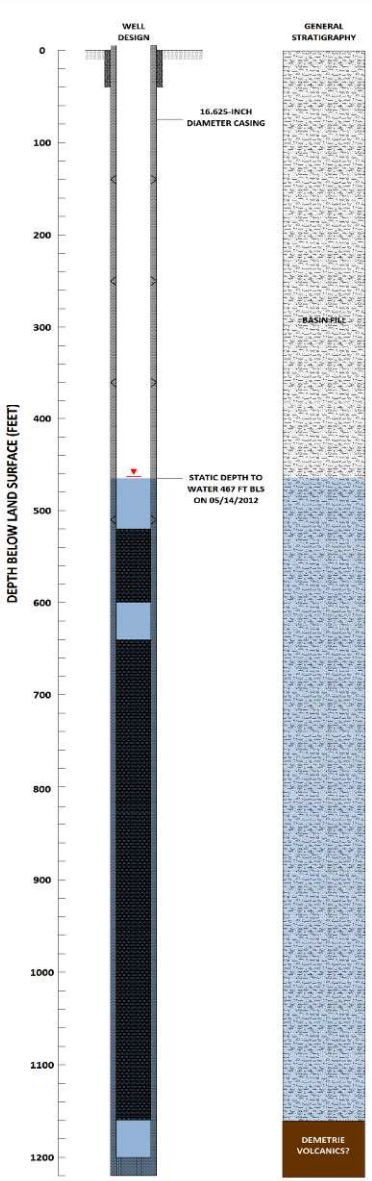
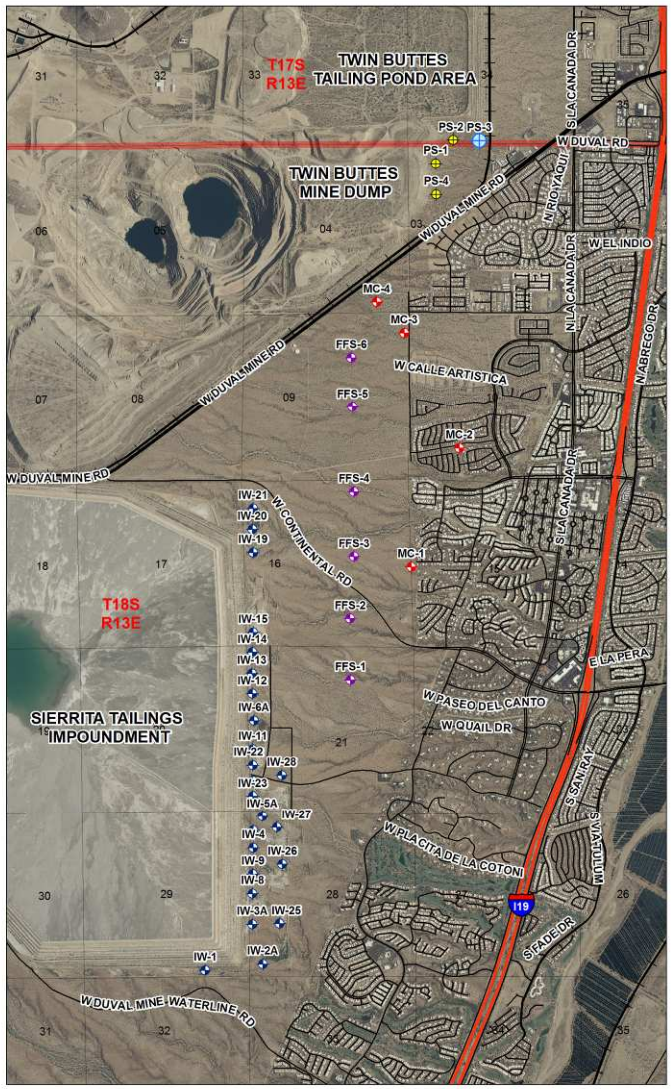
Engineering and Environmental Consultants











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SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

PS-3: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-17-13 34CDD
ADWR REG. NO.: 55-220863
DRILL YEAR: 2012

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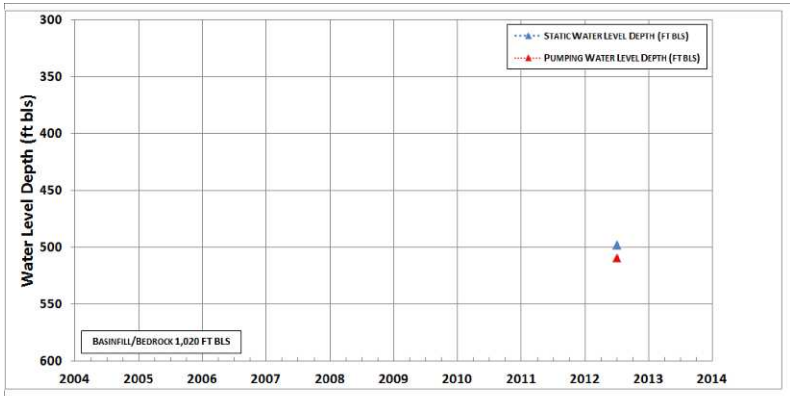

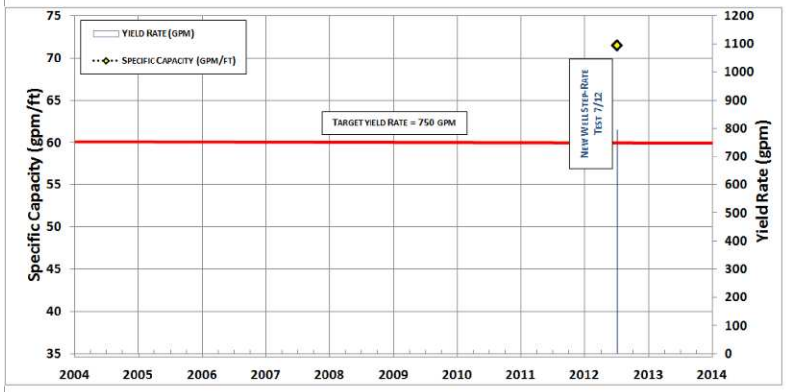

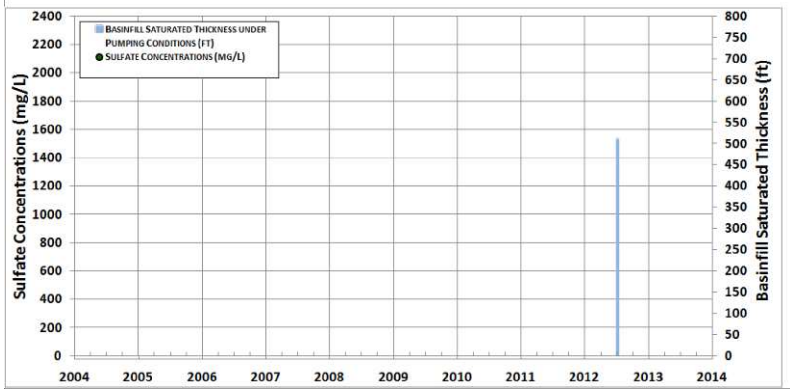

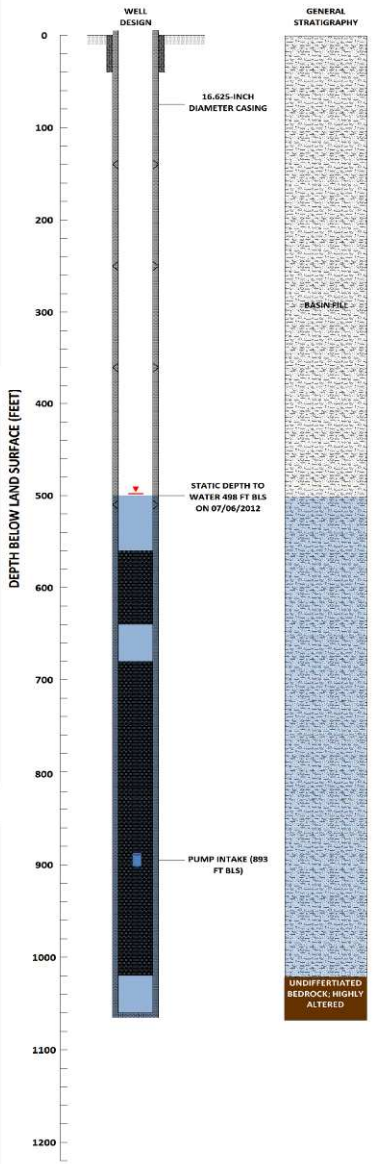

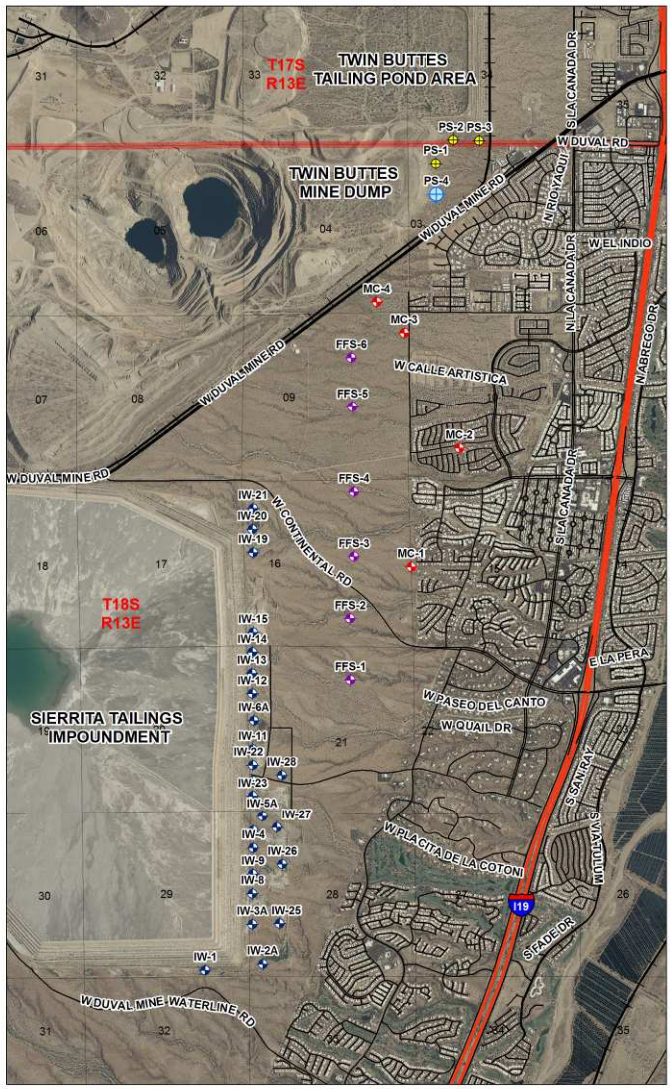

BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

PS-4: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 03BCA
ADWR REG. NO.: 55-220864
DRILL YEAR: 2012

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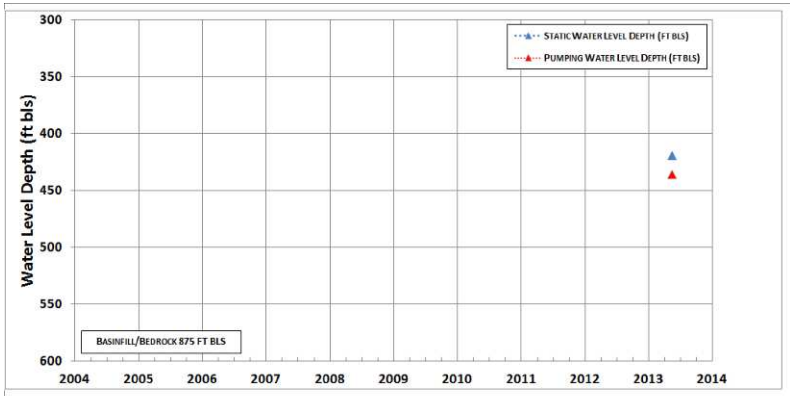

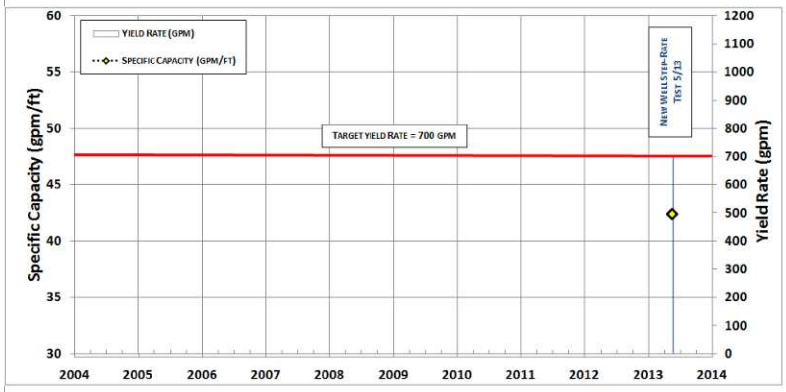

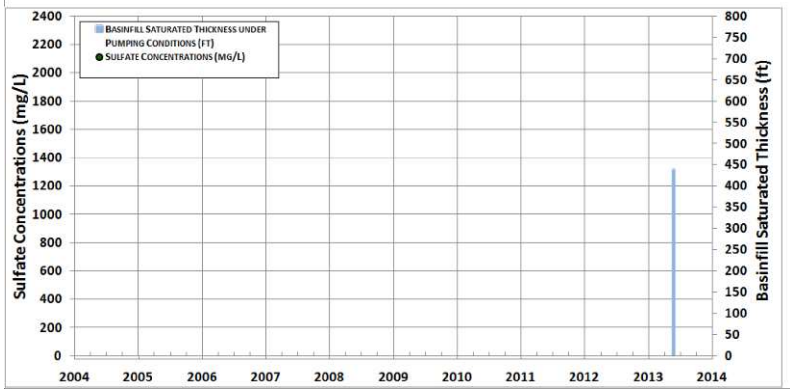

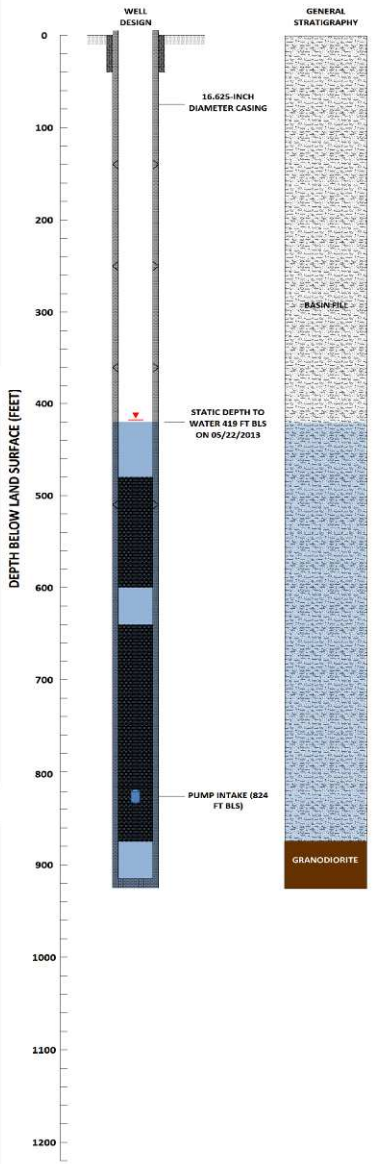

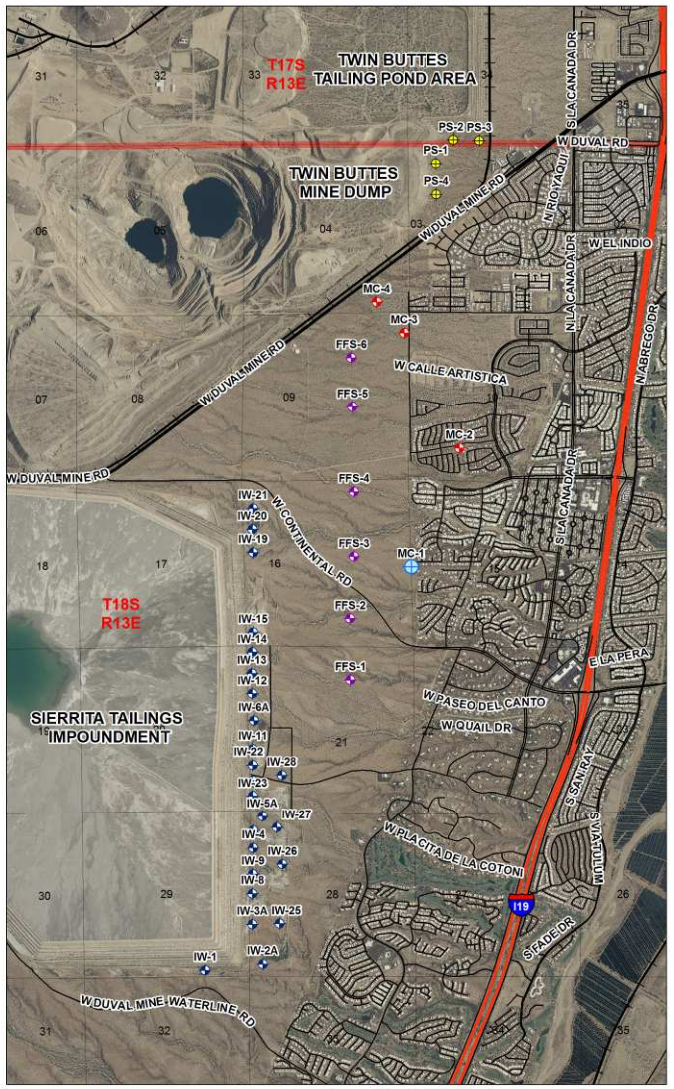

BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

MC-1: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 16DAA
ADWR REG. NO.: 55-221660
DRILL YEAR: 2013

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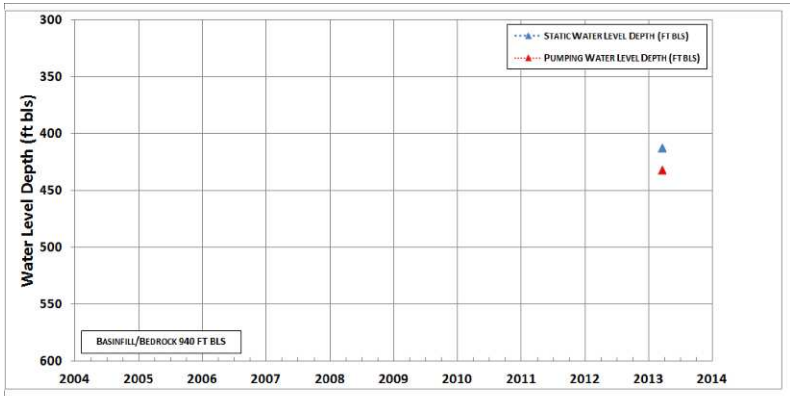

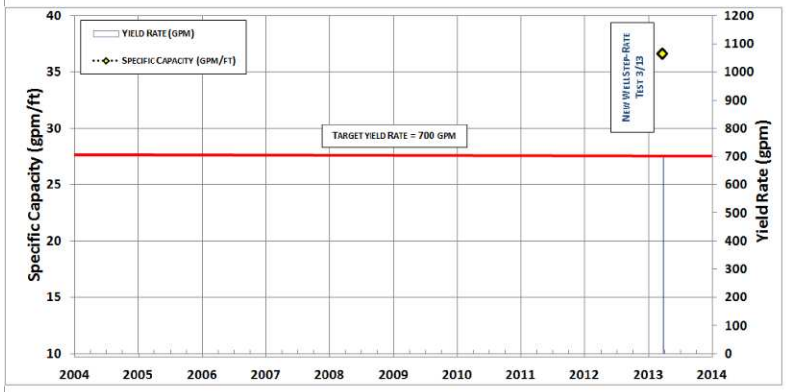

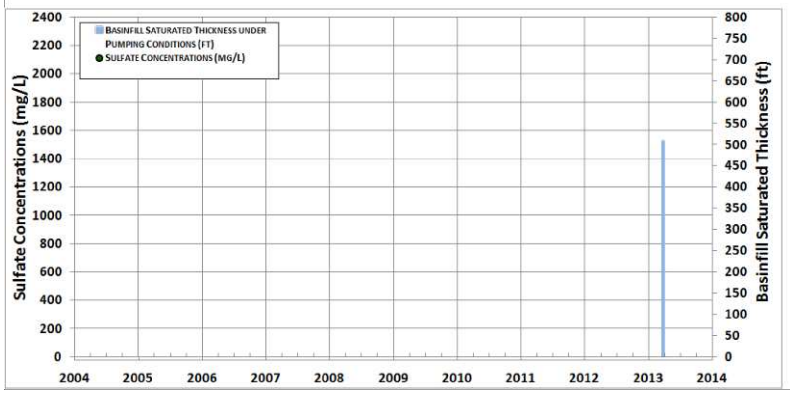

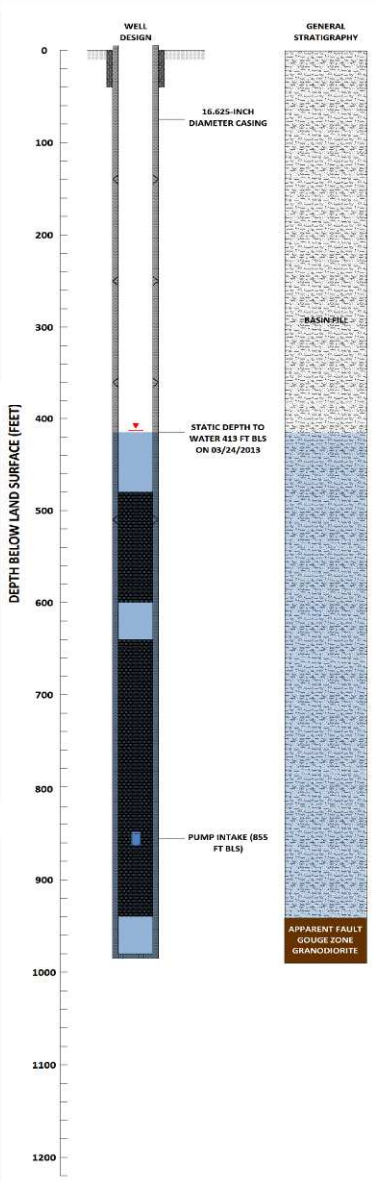

BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

MC-2: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 10CCB
ADWR REG. NO.: 55-221761
DRILL YEAR: 2013

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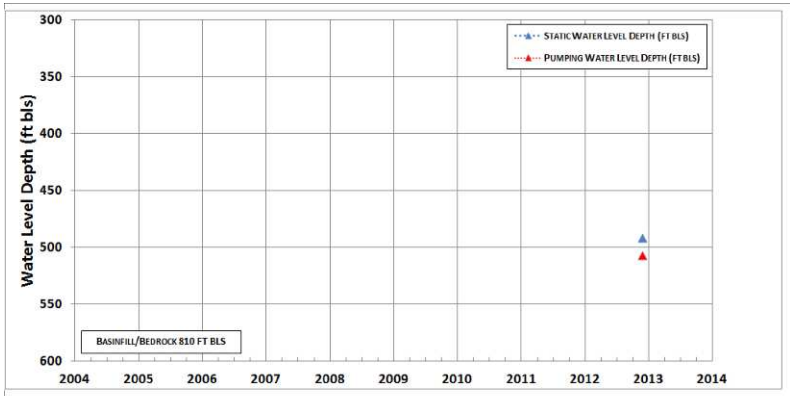
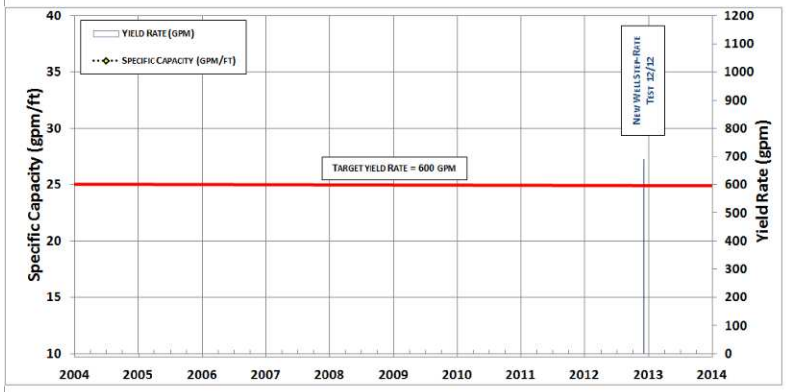
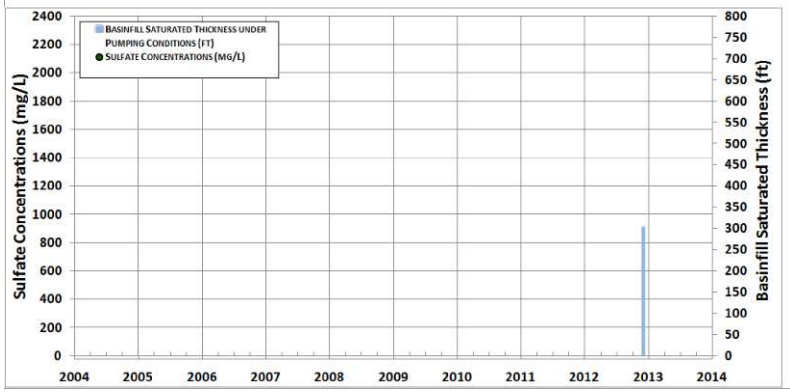
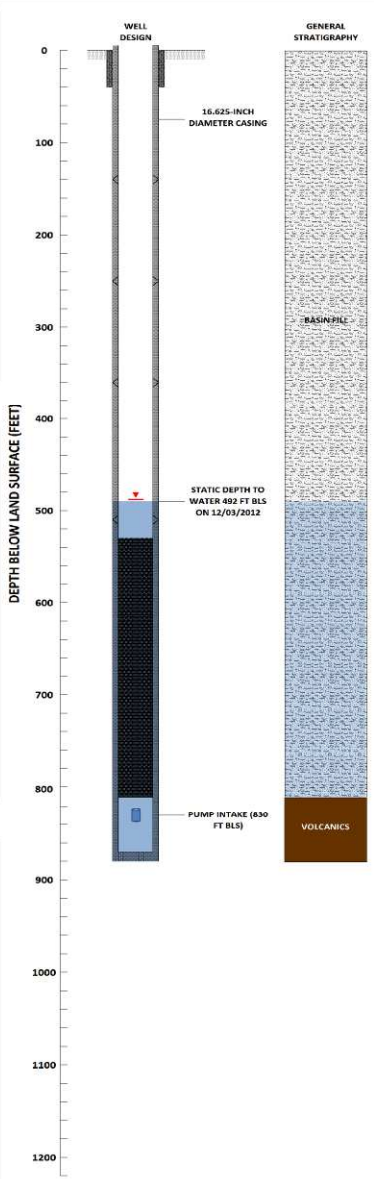
Engineering and Environmental Consultants









BasinWells ASSOCIATES PLLC
SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

MC-3: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 09AAA
ADWR REG. NO.: 55-221661
DRILL YEAR: 2012

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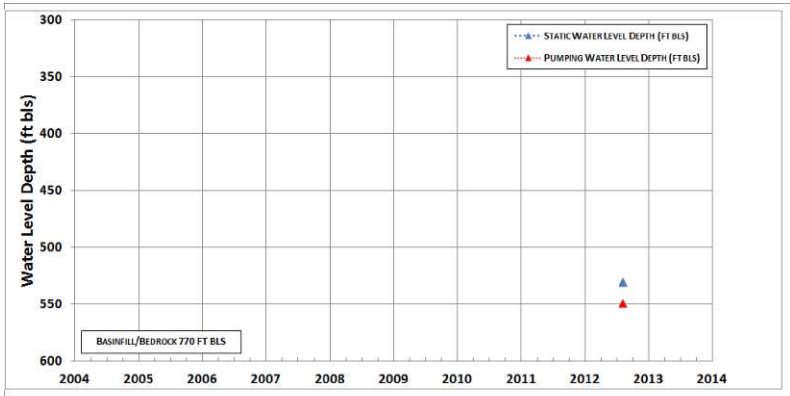
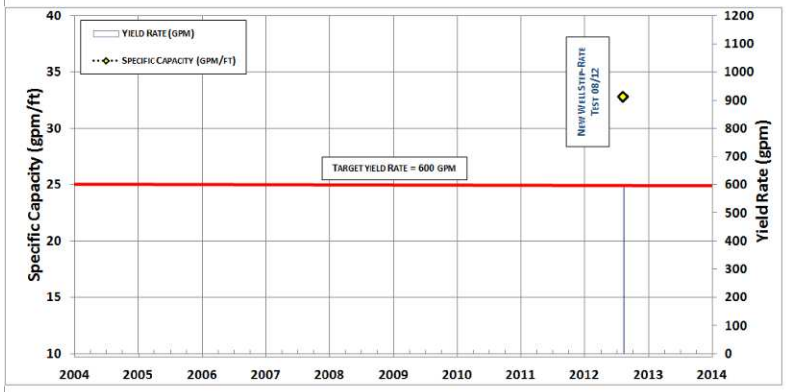
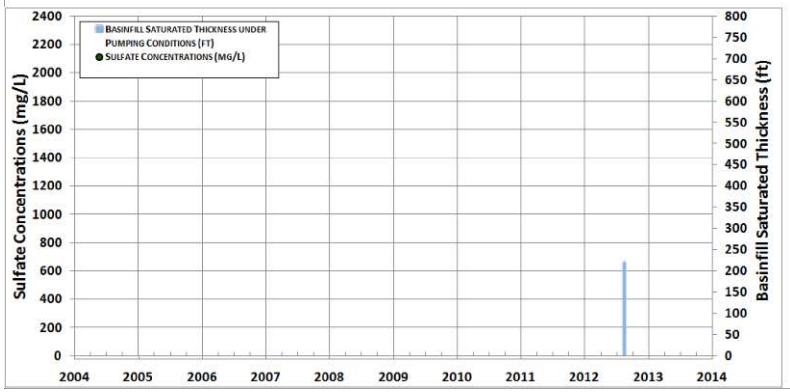
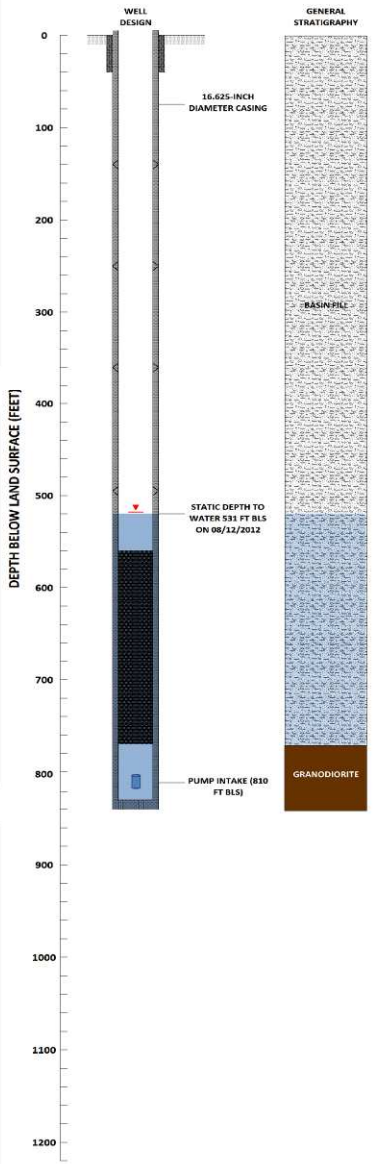
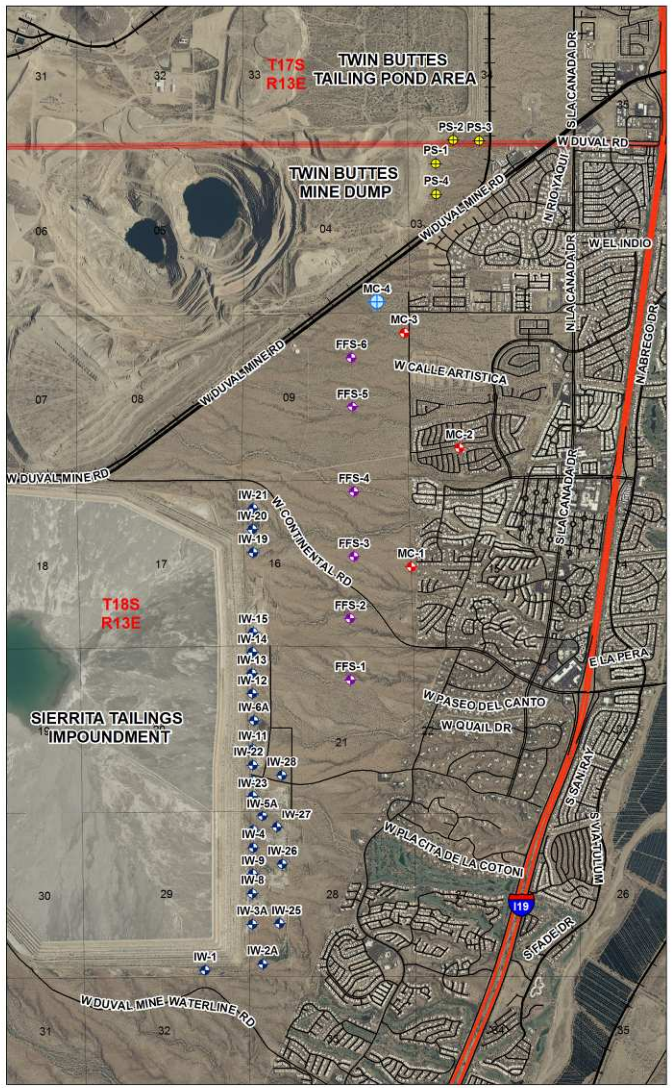
Engineering and Environmental Consultants











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FREEPORT-McMoRan COPPER & GOLD

MC-4: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 04DDC
ADWR REG. NO.: 55-220842
DRILL YEAR: 2012

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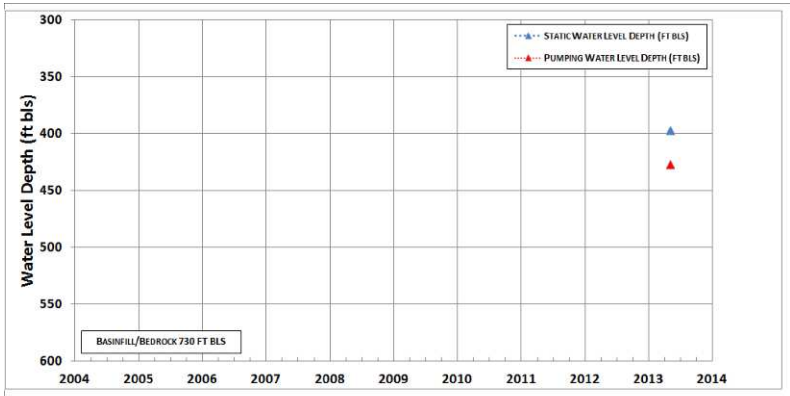
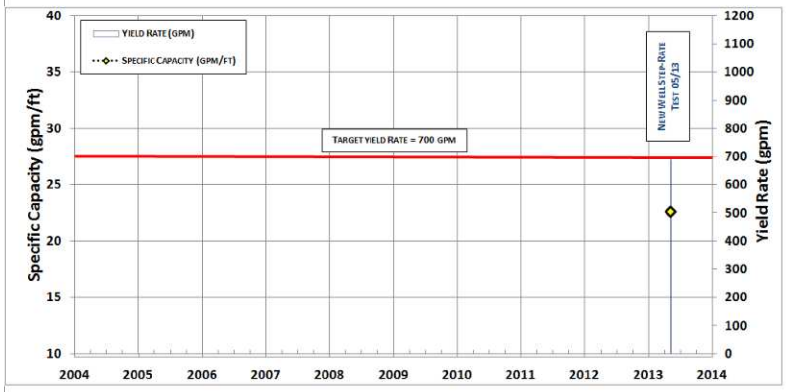
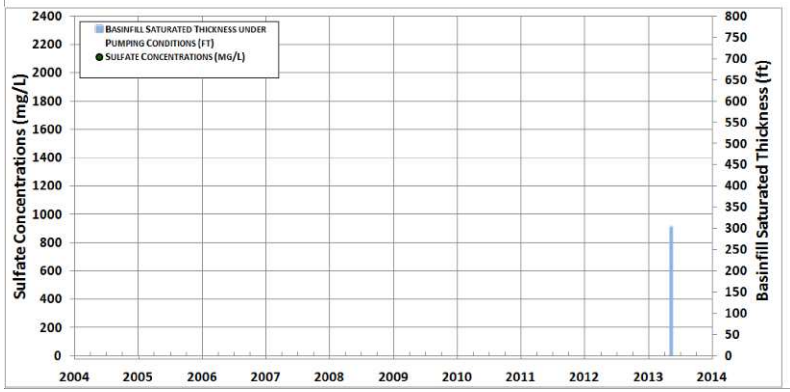
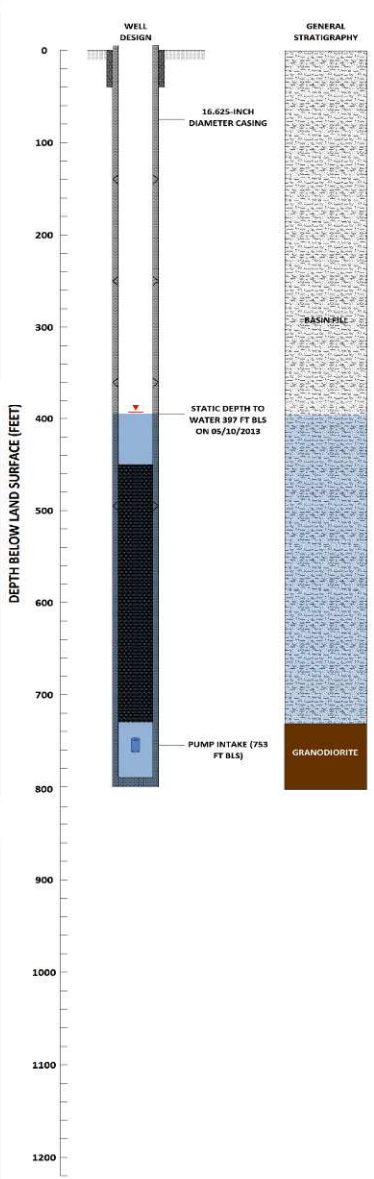
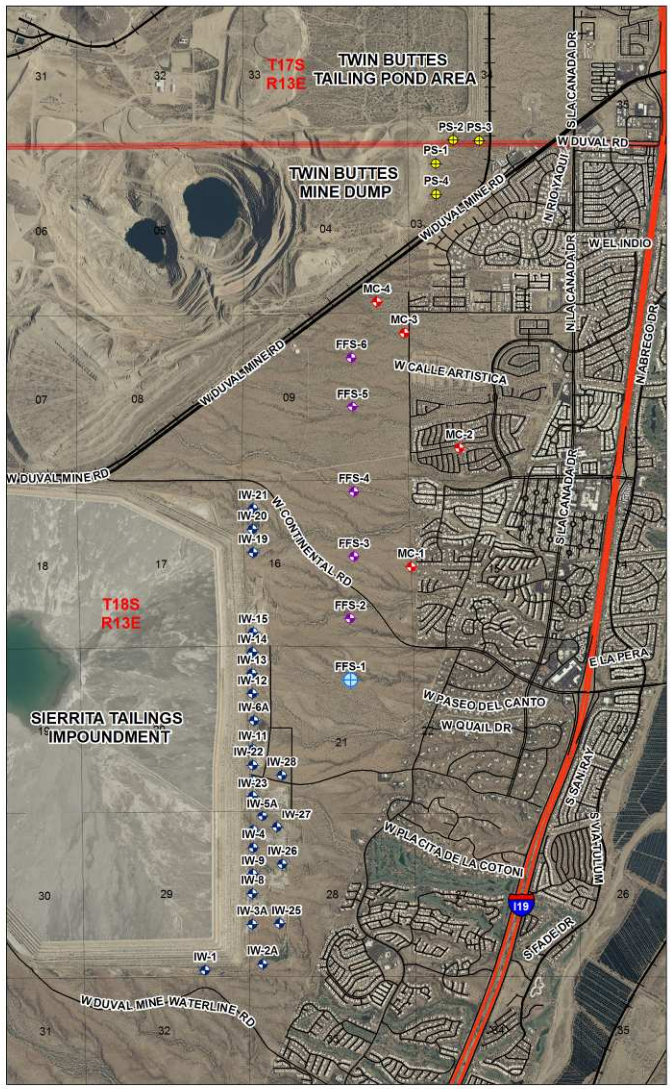
WestLand Resources, Inc.
Engineering and Environmental Consultants











BasinWells ASSOCIATES PLLC
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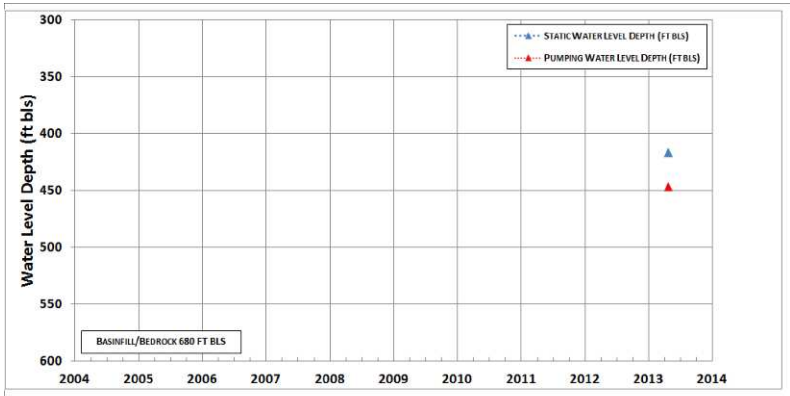
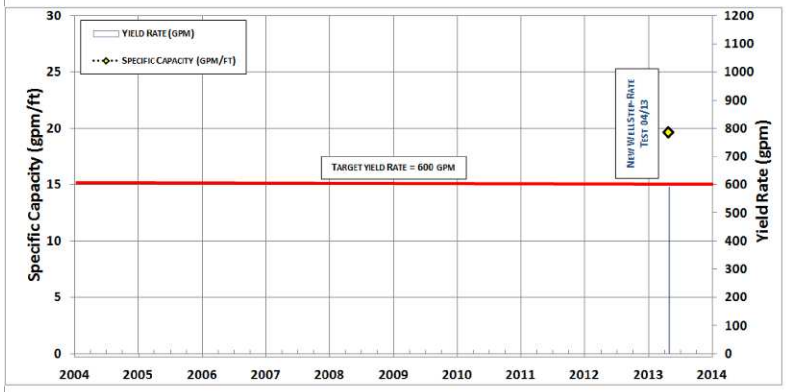
FREEPORT-MCMORAN COPPER & GOLD

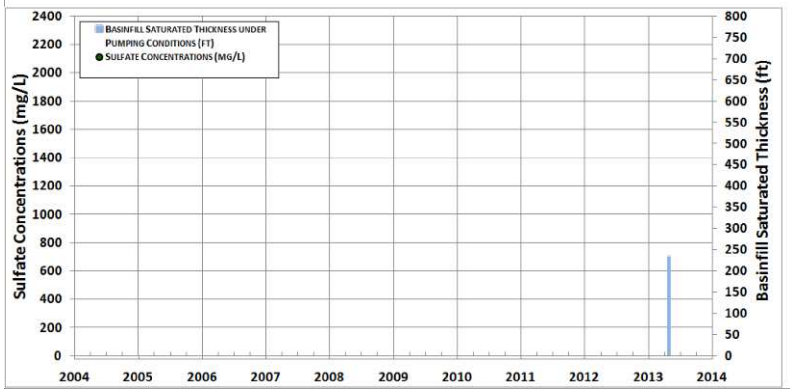
FFS-1: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

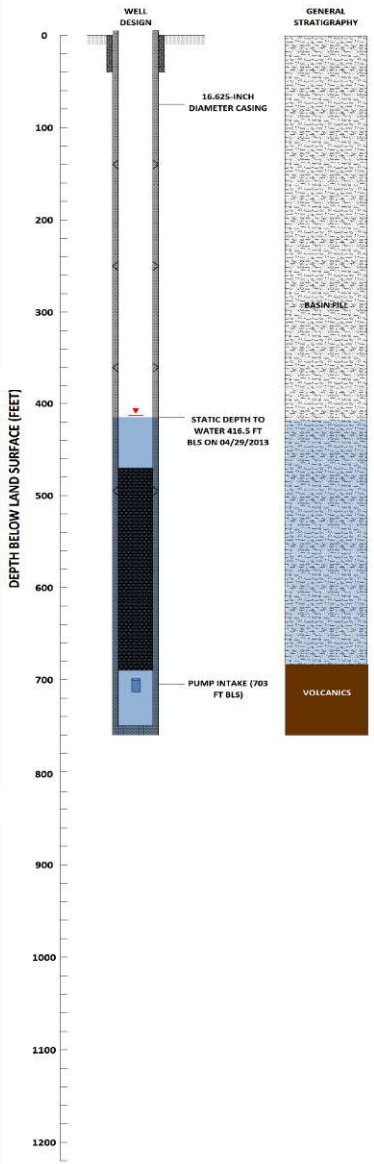
VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 21ABC
ADWR REG. NO.: 55-221662
DRILL YEAR: 2013









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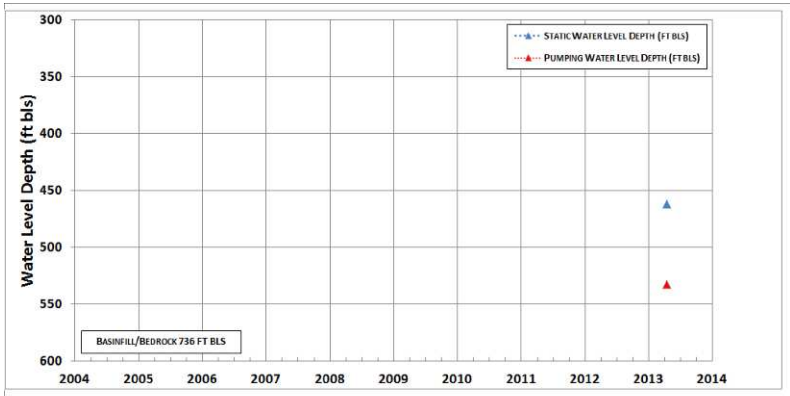
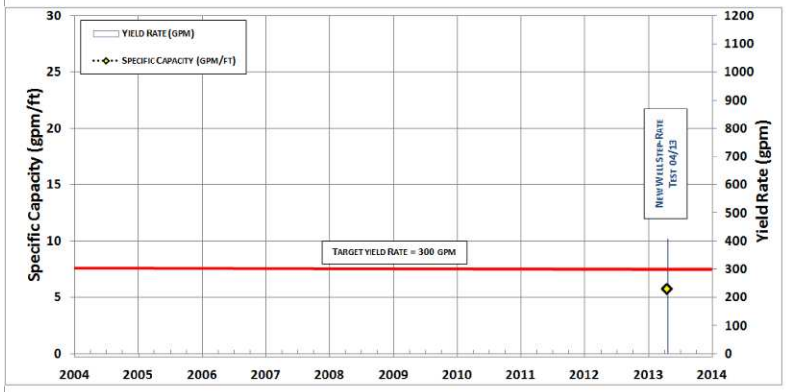
FREEPORT-MCMORAN COPPER & GOLD

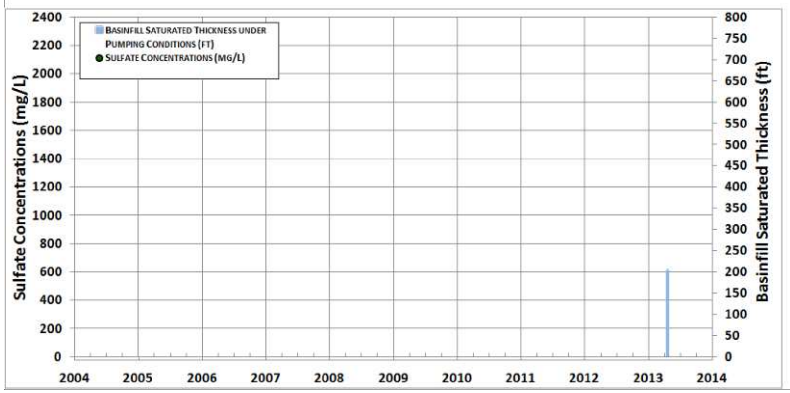
FFS-2: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

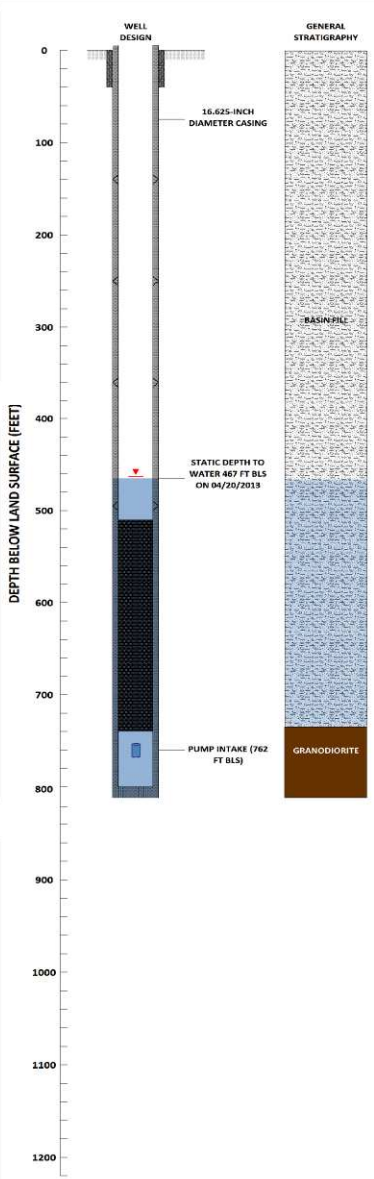
VERSION DATE: DECEMBER 15, 2013

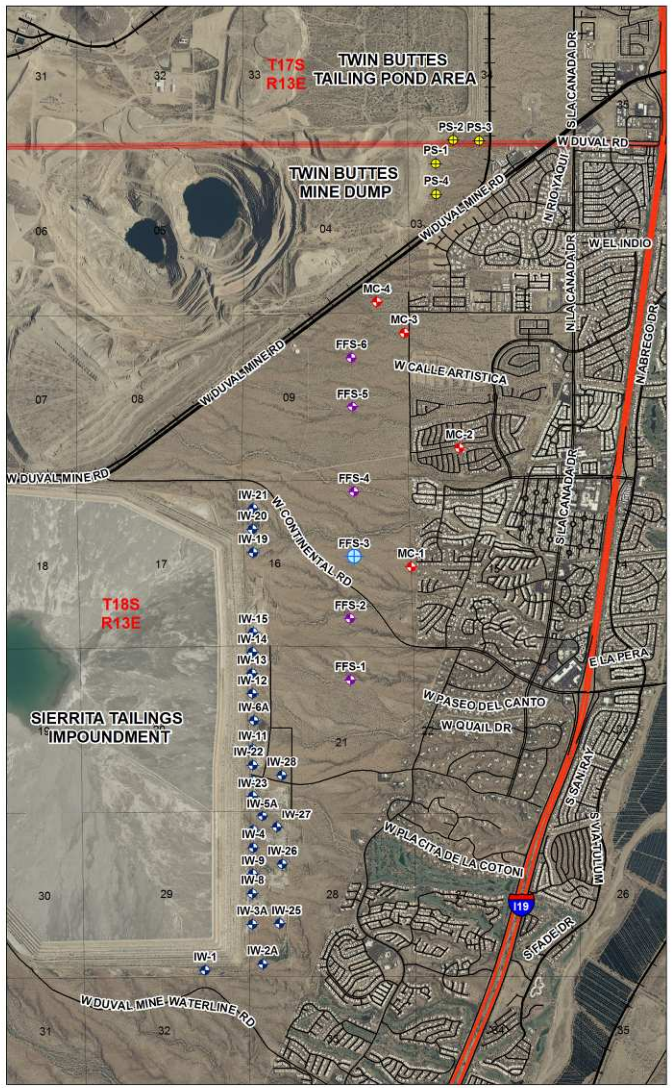
CADASTRAL: D-18-13 16DCA
ADWR REG. NO.: 55-221663
DRILL YEAR: 2013











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FREEPORT-MCMORAN COPPER & GOLD

FFS-3: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 16ACD
ADWR REG. NO.: 55-221664
DRILL YEAR: 2013

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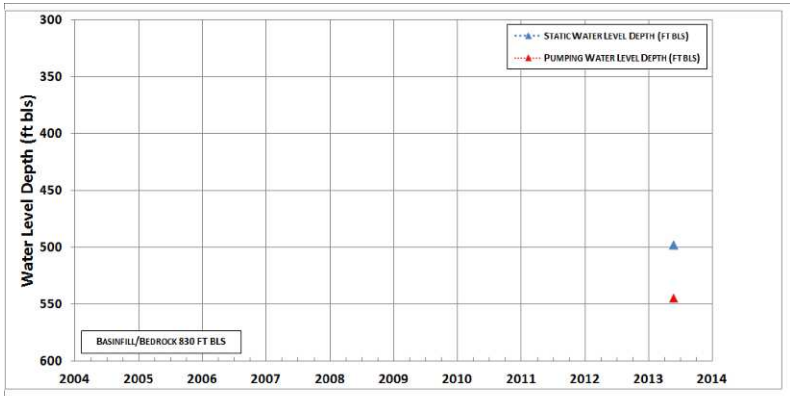

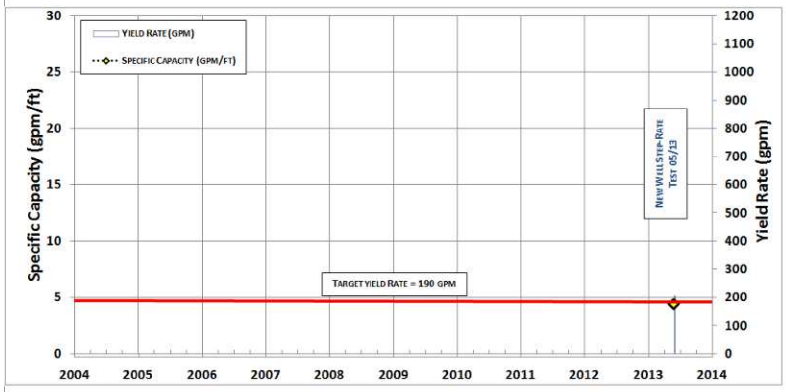

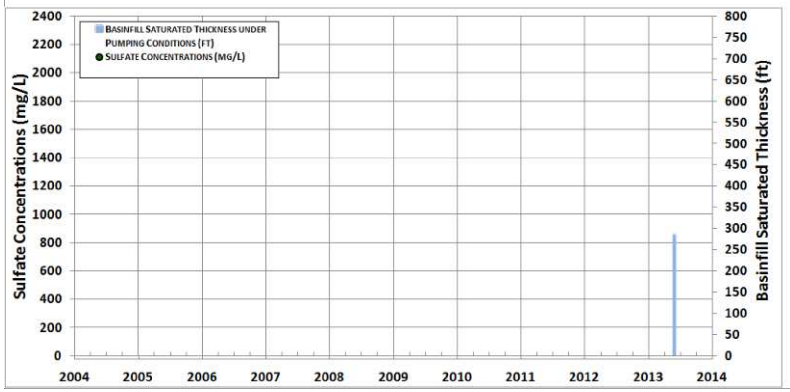

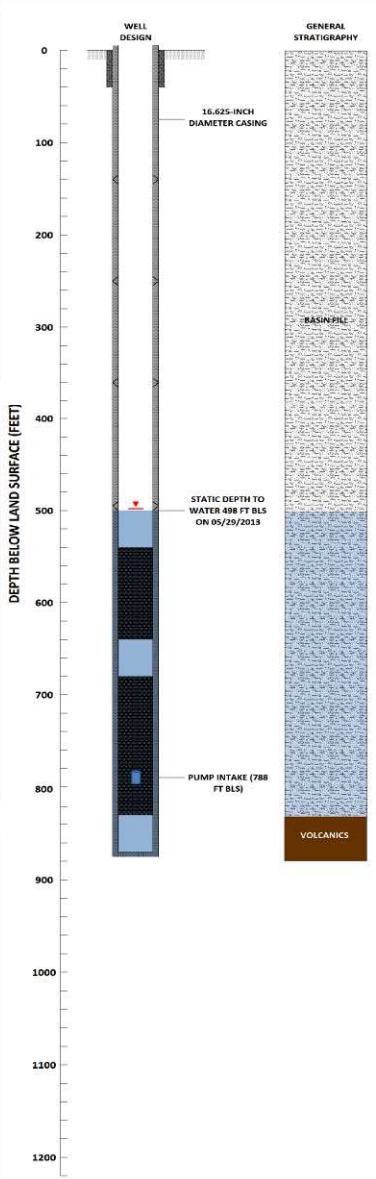

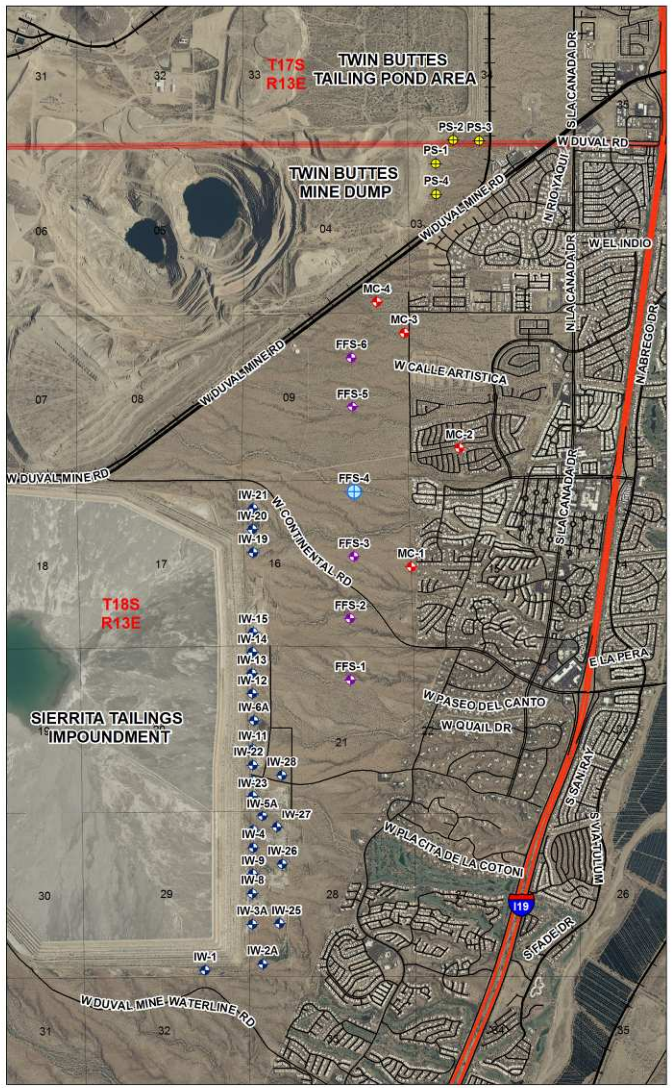

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FREEPORT-McMoRan COPPER & GOLD

FFS-4: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 16ABA
ADWR REG. NO.: 55-221665
DRILL YEAR: 2012

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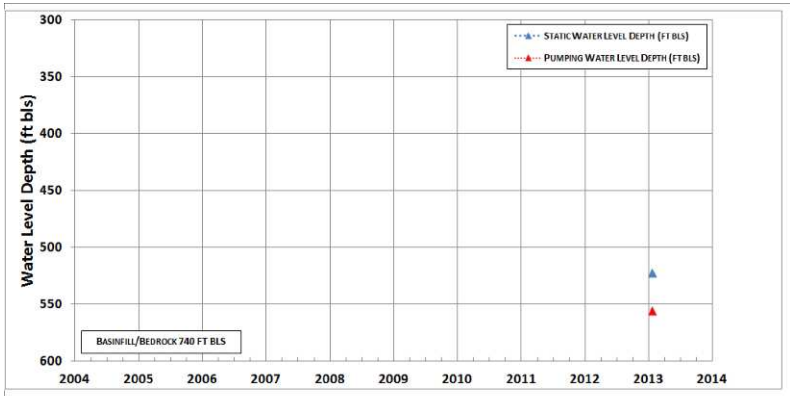

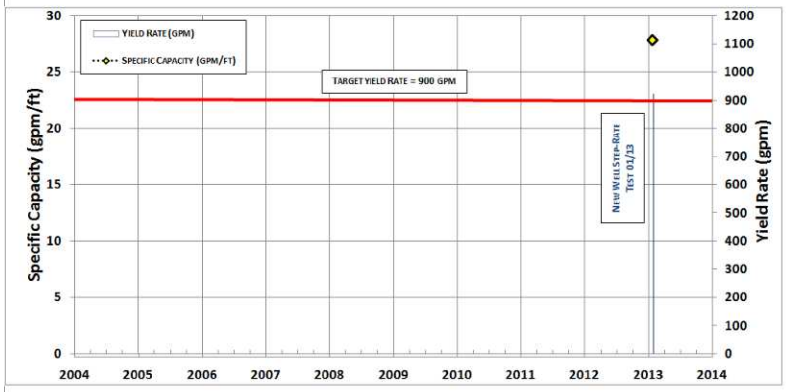

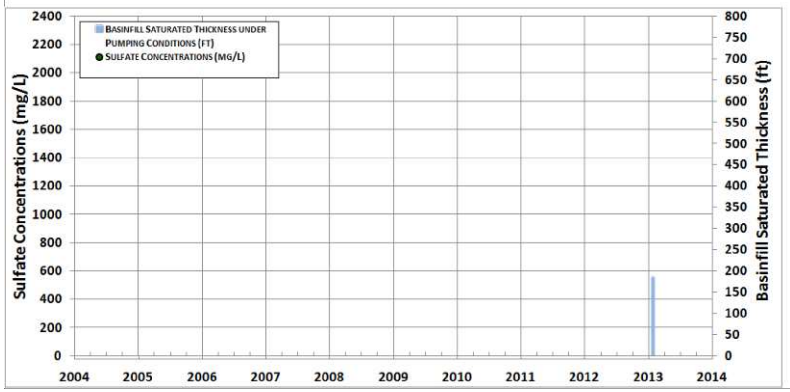

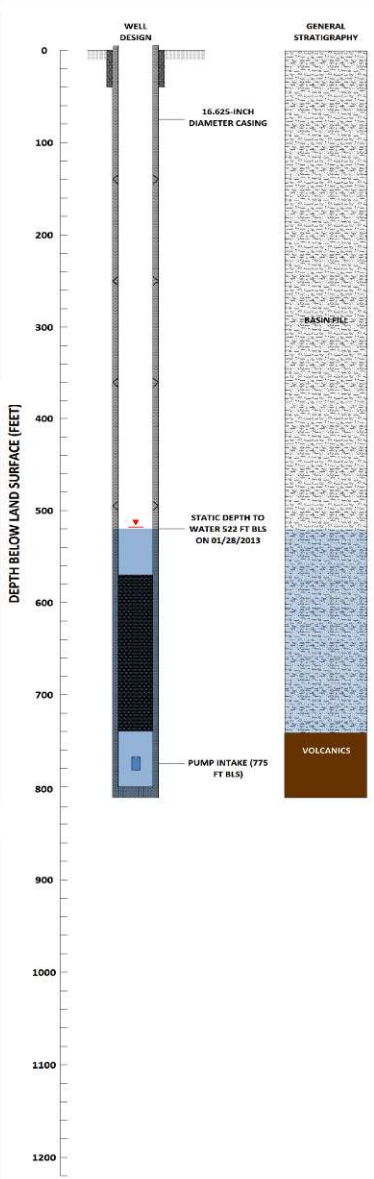

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FREEPORT-McMoRan COPPER & GOLD

FFS-5: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 09DBA
ADWR REG. NO.: 55-221666
DRILL YEAR: 2012

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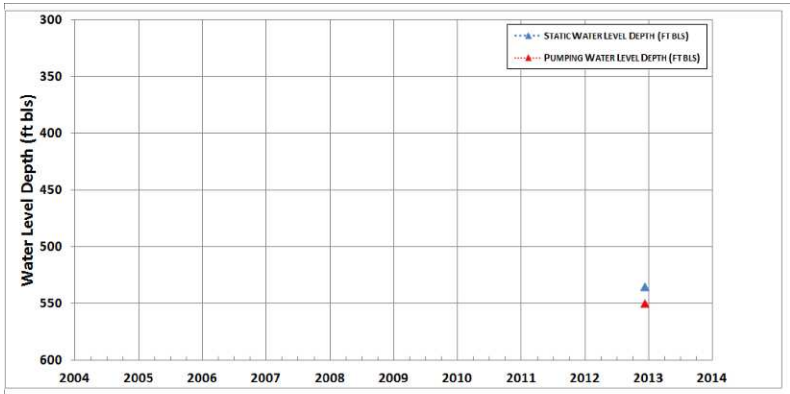

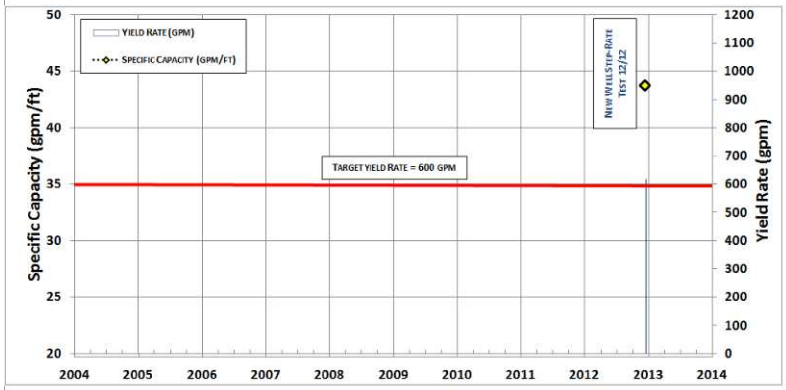

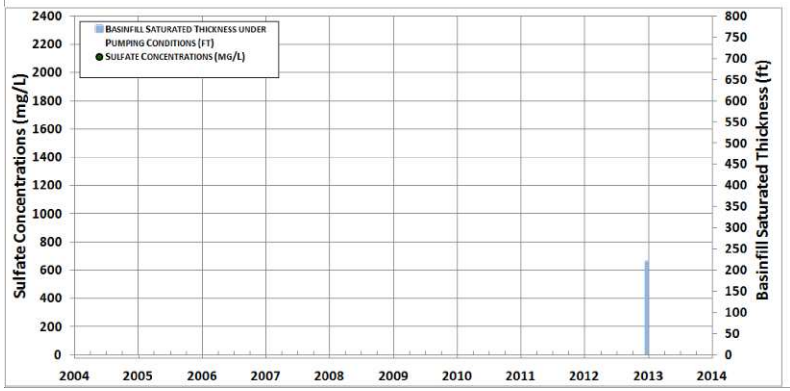

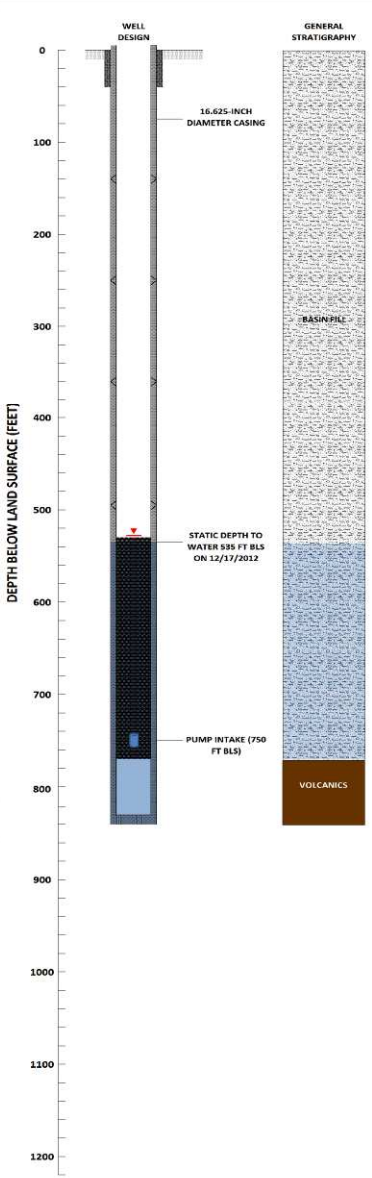

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SPECIALISTS IN GROUNDWATER DEVELOPMENT

FREEPORT-McMoRan COPPER & GOLD

FFS-6: WATER LEVELS, YIELD, SPECIFIC CAPACITY, BASINFILL SAT. THK. AND SULFATE

VERSION DATE: DECEMBER 15, 2013

CADASTRAL: D-18-13 09ACA
ADWR REG. NO.: 55-221667
DRILL YEAR: 2012

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Engineering and Environmental Consultants

APPENDIX B

Sample Field Forms

Monthly Well Meter Reading

Date:_____ Sampler(s):_____ Safety Inspection Completed?_____

	Time	Run Status	Totalizer	Flow	Pressure	Hours	AMPs	NOTES
IW-1								
IW-2A								
IW-3A								
IW-25								
IW-8								
IW-9								
IW-26								
IW-4								
IW-24								
IW-5A								
IW-27								
IW-23								
IW-10								
IW-28								
IW-22								
IW-11								
IW-6A								
IW-12								
IW-13								
IW-14								
IW-15								
IW-19								
IW-20								
IW-21								

Monthly Well Meter Reading

Date:_____ Sampler(s):_____ Safety Inspection Completed?_____

	Time	Run Status	Totalizer	Flow		Hours	AMPs	NOTES
FFS-1								
FFS-2								
FFS-3								
FFS-4								
FFS-5								
FFS-6								
MC-1								
MC-2								
MC-3								
MC-4								
PS-1								
PS-2								
PS-3								
PS-4								

	Time	Run Status	Totalizer	Flow		Hours	AMPs	NOTES
S-1								
S-2								
S-3								
S-4								
S-5								
S-6								

	Time	Run Status	Totalizer	Flow		Hours	AMPs	NOTES
RT-1								

Monthly Well Meter Reading

Date:_____ Sampler(s):_____ Safety Inspection Completed?_____

	Time	Run Status	Totalizer	Flow		Hours	AMPs	NOTES
ESP-1								
ESP-2								
ESP-3								
ESP-4								

Comments:

APPENDIX C

Pump Performance Evaluation Review Forms

Well Status Report: Date															
Well	Available		Run Status	Static Water Depth	Pumping Water Depth	Previous Totalizer Reading (Gal)	Totalizer Reading (in Gallons)	Previous Hour Reading	Well Discharge Pressure	Hours	Amps	Comments	Observed Pumping Rate (GPM)	Average Pumping Rate (GPM)	Target Pumping Rate (GPM)
	Yes	No													
Interceptor Well #1															250
Interceptor Well #2A															425
Interceptor Well #3A															500
Interceptor Well #25															450
Interceptor Well #8															425
Interceptor Well #9															250
Interceptor Well #26															350
Interceptor Well #4															80
Interceptor Well #24															100
Interceptor Well #5A															90
Interceptor Well #27															100
Interceptor Well #23															150
Interceptor Well #10															325
Interceptor Well #28															400
Interceptor Well #22															325
Interceptor Well #11															325
Interceptor Well #6A															90
Interceptor Well #12															150
Interceptor Well #13															0
Interceptor Well #14															75
Interceptor Well #15															50
Interceptor Well #19															200
Interceptor Well #20															0
Interceptor Well #21															150
FFS-1															900
FFS-2															900
FFS-3															300
FFS-4															190
FFS-5															1075
FFS-6															600
MC-1															900
MC-2															700
MC-3															600
MC-4															600
PS-1															600
PS-2															600
PS-3															600
PS-4															750
												Total Interceptor Well Flow	0	0	14,575
Canoa Deep Well #1															N/A
Canoa Deep Well #2															N/A
Canoa Deep Well #3															N/A
Canoa Deep Well #4															N/A
Canoa Deep Well #5															N/A
Canoa Deep Well #6															N/A
												Total Canoa Deep Well Flow	0	0	10990
Esperanza Deep Well #1												Checked on			N/A
Esperanza Deep Well #2												the last			N/A
Esperanza Deep Well #3												day of the			N/A
Esperanza Deep Well #4												month			N/A
RT-1															N/A

Return to Well Status Summary		Well-Specific Data for Trend Identification						
Date	Comment	Static Water Level (ft bls)	Pumping Water Level (ft bls)	Flow Rate (gpm)	Totalized Volume (gallons)	Pressure (psi)	Motor Amperages	Sulfate Concentration (ppm)

APPENDIX D

Procedures for Evaluation of Well Pump Performance

PROCEDURE FOR EVALUATION OF WELL PUMP PERFORMANCE

1. Obtain copy of pump performance curve from Interceptor Well Maintenance Record.
2. Determine column pipe diameter
3. Determine pump bowl setting from Interceptor Well Maintenance Record.
4. Input the following data into IW-Well Total Dynamic Head versus Flow spreadsheet provided to ELW (see example next page)
    a. Recorded Pressure Reading at discharge head of well
    b. Recorded flow in gpm from flowmeter at well
    c. Recorded pumping water level via sounding tube measurement.
5. Plot the given TDH versus the measured flow rate on pump performance curve.
6. Determine if the point is located in a satisfactory location for that pump curve.
7. If the point is not acceptable, flag the well for review of pumping equipment..

Example IW-Well Total Dynamic Head versus Flow

HAZEN-WILLIAMS WORKSHEET

Head Loss Parameters			Source
Column Pipe Diameter	6	in	Interceptor Well Maintenance Record
Pump Bowl Setting	730	ft	
Hazen Williams Coefficient	130		Estimated
**Pumping Water Level	480	ft below surface	Field Measurements
Pressure Reading at Discharge	75	psi	
Flow (gpm)	400	gpm	

Velocity	Column Pipe Head Loss*	**TDH**	**Flow (Q)**
fps	ft	ft	gpm
4.5	10	**663**	**400**

Assumptions:

* Column Pipe Head loss is estimated based on full-diameter flow through the column pipe. For more accurate column pipe headloss, please refer to the Column Friction Loss Table on following page.

** Pumping Water Level determined by sounding Tube Measurement

SIMFLO PUMPS

COLUMN FRICTION LOSS
OPEN AND CLOSED LINESHAFT
4" TO 12" COLUMN

SECTION	502
PAGE	1
DATE	12/1/97
SUPERCEDES	All Previous

COL. SIZE	4"		5"			6"				8"			
TUBE SIZE	1 1/2	2	1 1/2	2	2 1/12	1 1/2	2	2 1/2	3	1 1/2	2	2 1/2	3
SHAFT SIZE	1	1 1/4	1	1 1/4	1 1/2 1 11/16	1	1 1/4	1 1/2 1 11/16	1 15/16	1	1 1/4	1 1/2 1 11/16	1 15/16 2 3/16
GPM	COLUMN FRICTION LOSS (IN FEET) PER 100 FEET OF COLUMN												
100	2.90	5.30		.90	1.20								
200	9.50	17.00	2.20	3.10	4.00	.73	.95	1.40	2.20				
300	19.00		4.50	6.40	8.30	1.60	2.00	2.90	4.50				
400			7.50	10.50		2.70	3.40	4.70	7.60		.61	.74	1.05
500			11.20			3.80	4.90	6.90	11.80		.91	1.10	1.55
600						5.20	7.00	9.50	17.10		1.30	1.55	2.20
700						7.00	9.00	12.50		.98	1.80	2.10	2.90
800						8.90	12.00	16.20		1.30	2.20	2.70	3.70
900						11.50	14.50			1.60	2.80	3.20	4.70
1000										1.90	3.30	3.90	5.40
1200										2.60	4.50	5.50	7.50
1400										3.50	5.95	7.20	9.98
1600										4.50	7.55	9.20	13.00
1800										5.50	9.40	14.00	16.40
2000										6.70	12.50		
2200										7.90	15.10		
2400										9.40			
2600										11.00			
2800										12.80			
3000										14.70			
3200										16.70			

COL.SIZE	10"				12"			
TUBE SIZE	1 1/2	2	2 1/2	3	2	2 1/2	3	3 1/2
SHAFT SIZE	1	1 1/4	1 1/2 1 11/16	1 15/16 2 3/16	1 1/4	1 1/2 1 11/16	1 15/16 2 3/16	2 7/16
GPM	COLUMN FRICTION LOSS (IN FEET) PER 100 FEET OF COLUMN							
700			.50	.62				
800		.58	.67	.80				
900		.72	.83	1.00				
1000		.89	1.00	1.17				
1200	1.08	1.20	1.38	1.65				
1400	1.40	1.59	1.81	2.18		.90		1.02
1600	1.79	2.20	2.30	2.78		1.11	1.04	1.30
1800	2.20	2.50	2.88	3.50	.99	1.36	1.29	1.65
2000	2.69	3.02	3.50	4.25	1.20	1.60	1.57	1.95
2200	3.20	3.60	4.10	5.05	1.42	1.89	1.85	2.35
2400	3.75	4.20	4.80	5.95	1.68	2.18	2.18	2.76
2600	4.33	4.90	5.60	6.90	1.92	2.50	2.50	3.23
2800	5.00	5.60	6.40	7.90	2.20	2.87	2.90	3.69
3000	5.65	6.40	7.25	8.95	2.50	3.20	3.30	4.20
3200	6.35	7.15	8.20	9.99	2.80	3.60	3.72	4.73
3400	7.05	8.00	9.10	12.00	3.15	4.00	4.15	5.28
3600	7.85	8.90	10.50	13.50	3.50	4.40	4.60	5.90
3800	8.70	9.80	12.50	14.50	3.85	4.80	5.15	5.55
4000	9.60	12.00	13.50		4.20	5.25	5.65	7.25
4200	10.60	14.50	14.90		4.60	5.80	6.15	7.85
4400	11.60				5.10	6.30	6.70	8.60
4600	12.70	14.40			5.50	6.80	7.25	9.30
4800	13.80	15.60			5.90	7.30	7.90	10.10
5000	15.00				6.40	8.70	8.55	11.10
5500					7.60	10.40	10.30	13.30
6000					9.00	12.20	12.30	15.80
6500					10.60	14.10	14.40	
7000					12.30	16.20	16.80	
7500					14.10			
8000					16.00			

NOTE: For product lube use shaft size, for oil lube use tube size.