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April 13, 2015

VIA EMAIL AND U.S. MAIL

Nancy Rumrill
United States Environmental Protection
Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

Re: Gila River River Indian Community Comments on the Draft Class III Underground Injection Control Area Permit for the Proposed Florence Copper Project, Florence Copper Project Production Testing Facility, Florence, Pinal County, Arizona

Dear Ms. Rumrill:

The Gila River Indian Community (Community) submits its comments on the Environmental Protection Agency's (EPA) Draft Class III Underground Injection Control Area Permit for the Proposed Florence Copper Project, Florence Copper Project Production Testing Facility (Draft Permit). The Community's comments address our general concerns regarding the activities that EPA proposes to authorize under the Draft Permit, as well as the revised draft Memorandum of Agreement dated July 2014.

Thank you for your consideration of the Community's comments.

Sincerely,

Ian A. Shavitz

Enc.

COMMENTS OF THE GILA RIVER INDIAN COMMUNITY ON THE DRAFT CLASS III UNDERGROUND INJECTION CONTROL AREA PERMIT FOR THE PROPOSED FLORENCE COPPER PROJECT PRODUCTION TESTING FACILITY

April 13, 2015

Pursuant to the Environmental Protection Agency's (EPA) *Public Notice of Intent to Issue a Class III Underground Injection Control Area Permit for Florence Copper, Inc.*, the Gila River Indian Community (Community) submits its comments on EPA's Draft Class III Underground Injection Control Area Permit for the Proposed Florence Copper Project, Florence Copper Project Production Testing Facility (Draft Permit). The Community's comments address (i) general concerns regarding the activities that EPA proposes to authorize under the Draft Permit, and (ii) the revised draft Memorandum of Agreement (MOA) dated July 2014.

Florence Copper, Incorporated (Florence Copper) proposes to conduct in-situ mining operations that would involve injecting an acid mixture through above-ground wells into ore deposits (estimated to be 400 to 1,200 feet below the ground surface) and then extracting the copper permeated liquid through above-ground pumps. The dissolved ore would then be collected from the injection liquid that will have evaporated in very large leach ponds. To evaluate the feasibility of the proposed in-situ mining, Florence Copper seeks an Underground Injection Control (UIC) permit for a pilot production test facility (PTF) from the EPA Region IX. EPA has made a preliminary determination to issue a Draft Permit pending public notice and comment.

I. The Community Opposes EPA Issuing the Draft Permit

The Community opposes EPA issuing the Draft Permit due to the impacts that the proposed mining operations could have on the Community's water resources and cultural resources protected under Section 106 of the National Historic Preservation Act. On May 2, 2012, the Community Council passed Resolution GR 49-12, entitled, "Supporting the Town of Florence, Pinal County, Arizona and Opposing the Proposed In-Situ Leach Mining of Copper by Curis Resources Limited Also Known As the Florence Copper Project," opposing the risks presented by Florence Copper's proposed project, and the Community's Governor sent letters to the Arizona Department of Environmental Quality, the Arizona State Land Department, U.S. EPA, and Governor Brewer opposing the Florence Copper Project (Project).

a. <u>Impacts to Water Resources</u>

The Community has significant concerns that the proposed in-situ leach mining, located in close proximity to the Gila River, presents risks to the environment as well as to public health and safety, including potential groundwater contamination and the degradation of natural groundwater conditions that could affect the Community's reservation lands and its members located down-gradient from the mining site.

To better understand the potential impacts of the PTF, the Community retained Peter Mock, President and Principal Scientist at PMGC, Inc., to review and opine on the technical aspects of the proposed PTF and EPA's proposed permit conditions. *See* **Appendix A** for Mr. Mock's letter report (Mock Report), which is incorporated herein as part of the Community's Comments. Mr. Mock has concluded:

> "There are no long-term operations of the proposed [in-situ mining] technology to show Community leaders how environmental compliance works out in practice for this technology. The concerns of the Community's leaders and their neighbors in Florence for this type of mining so close to their boundaries would be best addressed with demonstrating long-term compliance with environmental laws and permit conditions at other sites."

Thus, the Mock Report validates the Community's concerns regarding the potential health, safety, and environmental impacts that could result from EPA issuing the PTF permit. Mr. Mock has noted that the Community's opposition to mining at this location, so close to the Community's Reservation and its growing neighborhoods, is reasonable in light of the nature of the mining; the need for dedicated, persistent technical work in everyday operations associated with the proposed mining technology; and lack of demonstrated experience in the industry in seeing such operations conducted with the necessary dedication and persistence over decades.

The Mock Report recognizes that in-situ mining presents significant safety consequences, both on the surface and in the subsurface. Protecting the adjacent and overlying aquifer, to the extent that this can be achieved, would require: (i) an abundance of expertise in subsurface fluid flow; (ii) hourly to daily collection of relevant data; (iii) hourly to daily interpretation of fluid movement; (iv) recognition of conditions indicating inefficient sweeping of the ore body or imminent escape between extraction wells; and (v) the authority and ability to adjust well flow rates in response to developing conditions different than expected. Given these practical and operational hurdles, coupled with the lack of sustained, accumulated experience in the application of this technology from which to demonstrate that protection of nearby developments that can be expected from typical operations precedent for similar operations, the Community has significant doubts that Florence Copper can perform in-situ mining with the requisite safety and precautions in place. In short, this is not the right location to perform this highly technical and unproven method of mining. For this reason, EPA should not grant the requested permit.

Finally, as discussed in more detail in the Mock Report, if EPA is to proceed with issuing the PTF permit, it is critical that the permit include provisions and conditions to provide the best chance for maximum protection. The Draft Permit lacks such conditions. For example, the Draft Permit's conditions of excess extraction and minimum one-foot water level-difference directed from outside the extraction wells do not ensure that the injected and reacted fluids will not escape the Project. Thus these conditions, as well as others identified in the Mock Report, must be revised and supplemented.

b. Impacts to Community Cultural Resources

In addition to the above concerns, the Project will impact resources protected under Section 106 of the National Historic Preservation Act. The Project's Area of Potential Effects (APE) is located within the ancestral lands of the Four Southern Tribes (Gila River Indian Community; Salt River Pima-Maricopa Indian Community; Ak-Chin Indian Community and the Tohono O'Odham Nation). As such, the APE contains resources that are of religious and cultural significance to tribes that are protected under Section 106.

Based upon surveys undertaken for the Project, EPA determined that the Project will adversely affect historic properties. Of particular concern to the Community is the Escalante Platform Mound (AZ:15:3[ASM]), which is identified by the Community as a Traditional Cultural Property (TCP). The National Register Bulletin 38 defines a TCP as a property that may be Register-eligible because of its association with the cultural practices or beliefs of a living community that are rooted in the Community's history and are important in maintaining the continuing cultural identity of the Community (National Register Bulletin 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties; 1990 Revised 1992; 1998). The Community has previously received and reviewed the Consensus Determination of Register Eligibility of the Escalante Platform Mound (AZ:15:3[ASM]) as a TCP under Criterion A (36 CFR 800). We again would like to express our appreciation for the EPA Region IX's decision to recognize the Escalante Platform Mound as a TCP based upon the obvious importance of this resource to the Community.

Thus, the Community opposes the Project on the additional ground that it will adversely affect a Community TCP. Avoidance of adverse effects to the Escalante Platform Mound, to the areal extent of the Escalante Platform Mound, and to all the recorded historic properties would occur if EPA Region IX <u>denies</u> issuance of a UIC permit to Florence Copper, Inc.

II. Community Comments on the Section 106 Draft MOA

As lead federal agency under Section 106, EPA has made a finding of adverse effect for PTF's undertaking. To resolve this adverse effect, EPA proposes to execute a Memorandum of Agreement (MOA). EPA's Public Notice on the Draft Permit requests comments on the Draft MOA. The Community's comments follow.

The draft MOA identifies fifty-one (51) historic properties recorded within the Project area, and addresses adverse impacts to seven historic (7) properties, including the Escalante Platform Mound (AZ:15:3[ASM]). Five (5) of seven (7) adversely affected sites will be subject to data recovery as detailed by the Historic Property Treatment Plan (HPTP), which has been prepared for Florence Copper by consultants Western Cultural Resource Management, Inc. The PTF will avoid two of the sites, however, these sites will still require archaeological monitoring and eventual installation of physical barriers (*i.e.*, fencing). It does not appear that the proposed Project will affect the remaining forty-four (44) recorded historic properties.

Through this public comment process, the Community has requested that no ground disturbance in connection with the implementation of the Project occur until all litigation of the Project is resolved. The Community makes this request to prevent unnecessary adverse effects to historic properties. The Community also requests that EPA include language in the MOA that stipulates that the HPTP must be finalized and accepted *before* the MOA is signed. The HPTP should address the whole Project area and all adverse effects on the historic properties and include language on how the HPTP will be implemented.

In addition to the above general comments, the Community offers the following additional comments to the draft MOA:

REFERENCE	COMMENT
Page 1, Fourth Whereas clause	Include the following language in red: "Whereas, the EPA has consulted with the following parties (the Consulting Parties) . . .
Page 2, Third Whereas clause	Amend to include the following additions and deletions in red: "Whereas, the GRIC has identified the "Escalante Ruin" (AZ U:15:3(ASM)) as a resource having ~~traditional~~ religious and cultural significance; and EPA has completed a consensus Determination of Eligibility under Criterion A of 36 C.F.R. 60.4 for its Traditional Cultural Value with concurrence from the SHPO to treat the site as a Traditional Cultural Property ~~for purposes of this consultation~~; and
Page 3	Include a Whereas Clause with the following language: "Whereas, the Tribes have apprised the EPA, SHPO, and other consulting parties of their opposition to the Project, and the legislative council of the GRIC has set forth a resolution in opposition to the project because the project would significantly impact, destroy, or alter cultural and archaeological sites containing cultural resources and sacred objects of the O'odham, would permanently and negatively alter the cultural and natural landscapes of the area, and would cause adverse effects on TCPs, including the Escalante Ruin, which is of particular religious and cultural significance to the Tribes; and"
Page 3	Through this public comment process, the Community has requested that no ground disturbance in connection with the implementation of the project occur until all litigation of the project is resolved. The Community makes this request to prevent unnecessary adverse effects to historic properties. As such, the Community requests Page 3 of the MOA to include the following language: "Whereas, GRIC has apprised the EPA that it opposes any ground disturbance associated with implementation of the project until after all litigation on this project is resolved in order to prevent unnecessary permanent and direct adverse effects to historic properties; and,"
Page 3, Section I.A.	Amend to include the following language in red: ". . .as directed in accordance with the Treatment Plan, which shall be part of, and thus subject to the requirements of, this MOA."
Page 4, Section	Amend to include the following addition in red:

I.B.	"... formal avoidance and minimization measures as set forth in the Treatment Plan. Other than this expected ground disturbance, FC and all other PTF activities shall avoid the Escalante Ruin (AZ:15:3[ASM])."
Page 5, Section III	Amend to include the following sentence: "EPA shall provide notice to the Consulting Parties of any request for such information prior to making that information available to the public."
Page 5, Section II.B.	Amend with the following additions and deletion in red as follows: " . . . do not require ~~an~~ any further amendment to this MOA."
Page 5, Section IV.A.1	Amend in red as follows: " . . . how the comments were considered and FC's responses for review."
Page 6, Section V.A.	Amend to include the following language in red: ". . . SHPO any newly discovered properties with the potential to be historic properties or any inadvertent effects . . ."
Page 6, Section VII.A.	Amend to include the following language in red: " . . . the implementation of the Treatment Plan and the MOA."
Page 7, Section VIII.A.	Amend to include the following language in red: "If any Consulting Party to this MOA objects in writing to EPA . . ."
Page 7, Section IX	Amend to include the following language in red: " . . . whereupon EPA shall consult with the other parties and Consulting Parties to this MOA . . ."
Page 8, Section X	Amend to include the following additions in red: " . . . or if the SHPO or ACHP determines that the MOA, including the Treatment Plan, is not being property implemented or followed and dispute resolution . . ."
Page 8, Section X.B.	Amend to include the following language in red: " . . . The signatory proposing to terminate this MOA shall notify all parties, including Consulting Parties, to this agreement . . ."
Page 8, Section XI	Amend to include the following additions and deletions in red: "This MOA shall expire upon completion of ~~seven years from the date of its execution. Should the FC PTF~~ the undertaking, including rinsing operations, plugging and abandonment of wells, and post-closure monitoring. ~~not be complete, or~~ If any signatory wishes to extend the duration of the MOA, they may propose an amendment to the MOA in accordance with Stipulation IX prior to its expiration. In no event, however, shall this MOA be amended to include, address or authorize any further in-situ copper recovery on FC's

	property beyond the PTF operation."
	The Community recommends that the following be added as a Stipulation under the MOA: "Prior to the occurrence of any ground disturbing activities, FC will coordinate with the GRIC, through its Tribal Historic Preservation Office (GRIC-THPO), to develop and implement cultural sensitivity training, which shall be attended by FC personnel and contractors that will be responsible for constructing the project. Further, prior to the occurrence of any ground disturbing activities, and as needed or requested by FC, FC personnel shall attend a cultural sensitivity orientation to be conducted by the GRIC-THPO and staff."

APPENDIX A

PMGC

Peter Mock Groundwater Consulting, Inc.

♦ Studies ♦ Simulations ♦ Reviews ♦ Communications ♦
♦ Strategic Advances ♦ Advanced Technical Tool Development ♦

Ms. Tana Fitzpatrick
Senior Assistant General Counsel
Gila River Indian Community
525 West Gu u Ki Road
Sacaton, Arizona 85147

April 13, 2015

REGISTERED GEOLOGIST
CERTIFICATE NO
21614
PETER A.
MOCK
Date Signed 4/13/15
ARIZONA, U.S.A.
Expires 9/30/15

AMERICAN INSTITUTE OF HYDROLOGY
Certificate Number
1689
Peter A. Mock
4/13/15
Hydrologist

Subject: Florence Copper Project – Technical Aspects of the EPA Underground Injection Control Well Permit

Dear Ms. Fitzgerald:

The Gila River Indian Community (Community) has requested my evaluation of the technical aspects of the proposed Florence Copper Project. As a consultant to the Community's Office of the General Counsel, I have been following the proposed copper mining near Florence with the Community for several years. I understand that my current evaluation will become part of the Community's comments on the current application by Florence Copper, Inc. (FCI) for an Underground Injection Control Permit (Permit) from the Environmental Protection Agency Region IX (EPA).

For my current evaluation, I reviewed selected parts of this Permit Application, Draft Permit and comments made by Southwest Value Partners (SWVP) in 2011-2012 on the application for an Aquifer Protection Permit (APP) from the Arizona Department of Environmental Quality (ADEQ) for the same proposed mining activity, as well as documents made available by SWVP regarding their successful appeal of the 2012 APP. I focused on those application materials describing hydrogeologic aspects of the Permits. The materials submitted by FCI for both Permits are essentially the same. SWVP hired Southwest Ground-Water Consultants and Lee Wilson & Associates to compile and interpret the available data and offer their interpretations of the technical issues related primarily to groundwater protection. I have considered the points of both sides and looked at selected supporting documents as necessary to evaluate the technical arguments.

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Executive Summary and Findings

Mining of copper is widespread and intensive in Arizona. Open pits, underground shafts and heaps and dumps of copper ore are familiar sights in rural Arizona. What is unique about the mining technology proposed by FCI is that it is conducted not by digging, blasting and hauling but by circulating a dilute acid solution through the undisturbed ore below the water table using wells. This proposed mining technology is called **in-situ solution copper mining of undisturbed ore**.

In 2012, through passage of Community Resolution GR-49-12, the Community formally joined with the Town of Florence in opposing the proposed mining of the Florence Copper ore body. The Community's opposition to mining at this location, so close to the Community's Reservation and its growing neighborhoods, is reasonable in light of the nature of the proposed mining technology. The proposed mining technology requires dedicated, persistent technical work in everyday operations and there is a lack of demonstrated experience in the industry in seeing such operations conducted with the necessary dedication and persistence over decades. The challenge in applying this proposed technology is that not only is it important to collect detailed data about the process from the wells, but those data need to be plotted and used in simulations on a daily basis to interpret what is happening and what may need to be adjusted to act in time as necessary. FCI did not show in their Applications through basic technical analyses that two previous tests of the proposed technology maintained control of injected fluids, so FCI's technical ability to recognize and react to loss of hydraulic control has not been demonstrated.

My specific findings at this time are as follows:

- In-situ solution copper mining of undisturbed ore requires:
    - an abundance of expertise in characterizing subsurface fluid flow,
    - hourly to daily collection of relevant data on fluid movement,
    - hourly to daily interpretation of fluid movement,
    - recognition of conditions indicating inefficient sweeping of the ore body or imminent escape between extraction wells, and
    - authority and ability to adjust well flow rates in response to developing conditions different than expected.

  These requirements are critical to provide maximum protection of the adjacent and overlying aquifer. This is a tall order to implement efficiently and safely.
- There is precedent for copper mining close to the Community: the ASARCO Sacaton Unit six miles northwest of the Town of Casa Grande and less than three miles south of the Community's south boundary, which operated from 1972 to 1984. Ore was only mined there and then taken to El Paso, Texas for processing; chemicals were not involved as they typically are at mining facilities. Nevertheless, the owner has since agreed to a $20,000,000 settlement to address lingering environmental concerns, so the Community's experience with nearby mining has not been positive from an environmental perspective.
- There is also precedent for a limited-scope, limited-duration investigative test of in-situ solution copper mining of undisturbed ore close to the Community: the Santa Cruz Joint Venture of ASARCO and Freeport-McMoRan Copper and Gold was operated just seven miles west of the

Town of Casa Grande from 1997 to 1998. It is unclear why neither FCI nor SWVP focused on this test, as it was widely discussed in the mining engineering literature as an archetype for this technology's development. The setting of the Santa Cruz Joint Venture ore body is nearly identical to, but deeper than, the Florence Copper ore body. The Santa Cruz Joint Venture test continued for nearly two years. The lack of discussion of findings from that test, not to mention the lack of a basic technical analysis of hydraulic control achieved during this test, is cause for the Community to have concern about FCI's technical ability to operate this proposed technology with the required expertise and diligence.

- An essentially identical test of the proposed technology, of similar size but shorter duration, was also conducted by a previous owner (BHP Copper) in the Florence Copper ore body from 1997 to 1998. BHP and FCI simply state that control was achieved without showing a characterization of how water flowed around the wells during the test. The lack of a basic technical analysis of hydraulic control achieved in this test is cause for the Community to have concern about FCI's technical ability to operate this proposed technology with the required expertise and diligence.
- The Permit being applied for is for a small-scale, limited-duration, investigative test of the proposed technology.
- The proposed Permit conditions of excess extraction and minimum one-foot water level-difference directed from outside the extraction wells do not ensure efficient mineral extraction or that the injected and reacted fluids will not escape the ore body. In groundwater flow, location matters and this key principal is not applied as it should be in these two proposed Permit conditions.
- The primary technical concept required to understand how to maintain control of the injected and reacted fluids – (water) **particle capture** - is not expressly stated or quantitatively used to show how it would be used to operate the project. The technical concept of particle capture is widely accepted, taught and used in remediation of contaminated groundwater and land-use based protection of drinking water wells.
- The absence of particle capture analysis from the extensive technical efforts made by FCI to date raises significant and justifiable doubts that FCI has assembled the necessary technical resources to successfully operate the Project.
- Collection of data for the proposed Permit conditions does not provide a basis for the operator to understand the capture of individual extraction wells on an hourly to daily basis, which, as I have stated, is critical to maintain hydraulic containment and thereby protect the surrounding area.
- The close proximity of the proposed Project to the established community of Blackwater within the Community's boundaries and the Town of Florence, as well as surrounding, rapidly-growing residential developments is cause for community leaders to be especially concerned about the safety consequences of the proposed operations both on the surface and in the subsurface.
- There is a lack of sustained, accumulated experience in the commercial application of this technology from which to demonstrate the protection of nearby developments that can be expected from typical operations.

- Even if individual existing drinking water wells are not impacted, operations that allow injected or reacted water to escape the capture of individual extraction wells may leave the common groundwater resource with concentrations of chemicals higher than they were before the mining operations.

In the remainder of this letter report, I expand on the findings listed above.

The Overall Proposed Mining Project

It is very challenging to find the essential facts about the overall proposed mining Project from the available information, but they can be extracted with some effort. I present below what I have learned based on my review of much of the information. In later sections I will focus on the Production Test Facility that is the subject of the current Permit.

The proposed full-scale Florence Copper Project considers approximately 45 operational blocks (my term) of classic “Porphyry Copper” ore deposit rocks between approximately 500 and 1500 (rounded numbers) feet below farmed and adjacent land. This is the relatively shallow local top of the hardrock beneath the basin fill deposits from which irrigation wells pump in the area. That is, the ore deposit is underneath the local groundwater basin, which in this location is prohibitively deep to mine by open pit, but is shallow enough to reach with wells. See Figure 1 for an overview of the locations of the Project, the Community and the town of Florence.

Each operational block would have approximately 30 injection wells and approximately 30 extraction wells for a total of 2,700 wells in all. These wells would be arranged like the squares in a checkerboard where the injection wells would be in the middles of the red squares and the extraction wells would be in the middles of the black squares. For optimal recovery, the injection wells are occasionally switched to be extraction wells and vice-versa.

As proposed, the approximately 45 operational blocks would not operate all at one time. Instead, phases (my term) of two to three operational blocks per phase would be active for three to four years, sweeping eventually over the ore body, overlapping in time by approximately a year. Depending on the amount of overlap, it appears that 120-180 wells total (injection and extraction) would be operating at any one time.

Within an operational block, the proposal is to run the wells such that the total of the flows out of the extraction wells would be larger than the total of the flows into the injection wells by between a few percent and 10 percent. It appears that for a typical operational block, the excess of extraction over injection would range between 200 gallons per minute (gpm) and 600 gpm, which is less than a typical irrigation well in the area. Two to three operational blocks would have the net pumping impact of one to two irrigation wells.

In 1997, EPA previously approved a request to declare the oxide part of the entire Florence Copper ore body as exempt from the adjacent and overlying drinking water aquifer. The oxide part is the upper part of the ore body and is amenable to the proposed technology. The lower or sulfide part is less amenable to the proposed technology. It also appears that EPA may have withdrawn that exemption, but this is unclear to me from the available record. EPA should clarify this point. The Arizona Environmental Quality Act of 1986 gave ADEQ a similar ability – to declare a hydrologic unit isolated - but this has not been granted for this Project.

The Current Permit – Production Test Facility

FCI has proposed a Production Test Facility (PTF) in the current Permit Application, consisting of approximately one quarter of one operational block near the west side of the potential full-scale Project. The PTF specifically comprises four injection wells and nine extraction wells separated by 70-foot spacing. The PTF will have wells open to a thickness of approximately 800 feet of the ore body. The ADEQ APP, which was rejected by the Arizona Water Quality Board and remanded to ADEQ for further consideration, also addressed only the PTF.

While the technical points made in the applications for the APP and the current Permit bear some applicability on subsequent consideration of the full-scale project, my comments on the current Permit are only for the PTF. The perspective of the full-scale project is necessary to understand the technical objectives of the proposed PTF. The points in these PTF comments may be changed or modified by observations or calculations derived from further consideration of additional information that currently exists or information reported from operation of the PTF, if it is approved and the PTF work is commenced. It is critical that the Community and others be given the opportunity to review and comment on any proposed mining operations beyond the PTF as described in the current Permit Application.

While the intensively and pervasively fractured nature of the oxide ore body, the arrangement of the injection and extraction wells on a checkerboard-like pattern (i.e., alternating between injection and extraction), and their relatively close proposed spacing (tens of feet) may provide the operator the ability to adjust the operations so that the injected fluids are effectively contained, I am not convinced that this will be the case as I will soon explain

Observation wells are proposed around the outmost extents of the process for the purpose of monitoring the containment. I agree with the SWVP's request for additional observation wells around and above the PTF. I also assert that there is a need for resistivity sensors to be installed in the outermost borehole wall of each well (as each can be used for either injection or extraction) in and just above the exclusion zone and that these sensors should be monitored on at least a weekly basis during and after operations. FCI should also monitor water quality by sampling from selected locations using small-diameter monitoring wells open to the interval above and near the top of the exclusion zone. Therefore, FCI should conduct careful sampling of monitoring wells above the exclusion zone and have those samples analyzed for the same chemicals selected for analysis in other monitoring wells surrounding the PTF.

General Risks to the Community and its Neighbors

As to the groundwater resource, the Applications assert that FCI obtained groundwater pumping rights, including SCIIDD and industrial pumping rights, when they purchased the property for the Project. The pumping for the Project includes water for the injection and the net of injection and extraction from the process. For the PTF, the net extraction for the process is 60 gpm for two years. This would have a minimal impact on water levels at the Reservation boundary in comparison to on-going pumping in the area for irrigation.

There will be transport and storage of a relatively narrow range of chemicals, chief of which by volume will be sulfuric acid. A single central facility is proposed to be on-site for handling the injection and extracted fluids. A substantial web of pipes would need to be run between the wells and the facility. Any Permits should include conditions that clearly mandate compliance with the highest standards in handling of the sulfuric acid in all aspects of the PTF, including in handling sulfuric acid in the network of pipes radiating from the facility.

The facility will remove the copper using a well-established technique called solvent extraction/electrowinning ("SX/EW") from the extracted solutions and also recycle the solutions for injection. The chemicals other than sulfuric acid would largely reside at the central SX/EW facility. The solvents of the solvent extraction process are the next largest concern in terms of volume. As with the sulfuric acid, compliance with the highest standards in handling of the solvents (and any other chemicals) should be demanded. It appears from reading Section E.6.d. of the Draft Permit that organic compounds, including diesel-range petroleum hydrocarbons, from the SX/EW process will not be completely removed in the recycling treatment train and, in fact, up to 10 mg/L (10,000 ug/L) of these materials would be allowed to be sent to the injection wells. This is not acceptable to the Community. No compounds other than those of the sulfuric acid and materials dissolved from the ore body should be allowed in the injected water.

There is a rail line running close to the project that does not pass through the Community. To provide maximum protection to the Community, the Community should request that sulfuric acid and other chemicals being transported to and from the Project not pass through its boundaries.

Specific Risk from Chemicals in the Subsurface

The remaining risks have to do with the injected and reacted fluids in the subsurface. Starting with the wells, there is extensive experience in well design to maintain integrity under delivery and collection of sulfuric acid. Any Permit should demand compliance with the highest standards in well construction and associated piping.

A related issue is finding and definitively sealing any existing boreholes in order to eliminate any pathways for the injected or reacted fluids other than in the ore body below the exclusion zone. The selected exclusion zone is the top 40 feet of the oxide ore body and is intended to be a protective buffer between the activity of the proposed mining technology and the overlying basin fill aquifer. The injected and reacted fluids should be contained within the ore body below the exclusion zone and laterally within the proposed project boundaries. This is done by arranging the wells and applying extraction and injection flow rates at each well such that the movement between them is controlled. Subsurface control through control of individual well flow rates is the key activity to watch for here – both for efficient recovery and for protection.

Since the subsurface is not going to be exposed or exhaustively sampled, implementation of the proposed mining technology requires a combination of monitoring and simulation. Simulation fills out the picture where monitoring is not available. While it is important to recognize that this does not guarantee success, the appropriate combination of monitoring and simulation leads to the highest chance of success in contacting as much of the ore body as possible and to the highest chance of recognizing and mitigating escape of the injected and reacted fluids. Simulation of groundwater flow and advective particle tracking on an hourly to daily basis is crucial to provide the operator with the information needed to recognize conditions that require adjustments to individual well flow rates in time to make those adjustments.

The Applications and the Draft Permit lacks this as a central feature of the Permit. Instead, FCI relies on two proposed Permit conditions to ensure hydraulic containment and thereby protection of the adjacent and overlying aquifer (named in the Application materials "the Lower Basin Fill Unit"). These two conditions however are not protective in light of the hydraulics of natural groundwater flow systems (as are present in the Florence Copper ore body). The two proposed Permit conditions are:

1) Excess Extraction - extracting more in total than is injected in total on a daily basis
2) One-foot Inward Gradient - water levels in the extraction wells maintained one foot lower than in observation wells placed straight outward with respect to the ore body from those extraction wells.

The problem is location with respect to the background/surrounding flowing groundwater. An in-situ solution copper mining system can be operated in full compliance with these two conditions and yet leak injected and reacted fluids around its sides and downgradient extents. **Particle Capture Analysis** is the relevant technical analysis for this situation. This concept is widely taught and applied in groundwater contamination remediation where "pump and treat" or "contaminant containment" systems use particle capture analysis to place and select pumping rates to avoid loss between the pumping wells. Particle capture analysis is also widely used to delineate areas on the land surface above the volumes of groundwater headed to a water supply well in wellhead protection studies. Indeed, 20 years ago the Community's DEQ conducted a "Wellhead Protection" study, funded by EPA, that delineated the areas overlying groundwater headed towards its water supply wells using particle capture analysis.

In the extended recent discussions of the Permits and the Appeals, the words "hydraulic containment" are used, but the clear concept of particle capture analysis is not expressly stated and used as it should be. Particle capture analysis directly and quantitatively addresses hydraulic containment. The reliance by FCI on the above two Permit conditions indicates that FCI may not understand particle capture analysis and certainly has not made it a foundation for the proposed operations. Again, while there is no guarantee of safe implementation of the proposed mining technology, particle capture analysis provides the best chance for being able to implement safe implementation.

Particle capture analysis is needed during implementation of the proposed mining technology because there are slopes to the groundwater levels at the depths of the ore in this area. These slopes drive groundwater to move into the ore at its upstream end and out of the ore at its downstream end. Here the groundwater flow through the ore is largely to the northwest as is clearly documented in the Permit application materials with water levels collected for several years in wells open only to the ore body. For the purpose of this discussion, I will call this the background flow of groundwater.

If there is a relatively large background flow of groundwater in the ore body, then the extraction wells need to be closely spaced and pumped at sufficiently high rates to compete against the background groundwater flow and completely capture the water flowing between them. If any two adjacent extraction wells on the downstream end of an ore body operated on with the proposed mining technology are too far apart and/or do not each pump enough, the wells cannot stop the groundwater flowing at the midpoint between them. Also, water can escape laterally (perpendicular to the background groundwater flow) out and away between adjacent extraction wells on the side edges of the well groups.

SWVP in their appeal of the APP argued for enhanced monitoring on the downstream side of the PTF, and this contributes to enhancing the chances of detecting escape from the process zone. However, this approach does not allow for the ability of the extraction wells to pull the water back in after the water has contacted the downstream monitoring wells (should the monitoring wells be sufficiently close). Also, agreement to place monitoring wells does not lead to use of that data to calculate particle capture and allow timely recognition of undesirable flow conditions. This needs to be done on a frequency that allows the operator to act on that recognition – specifically select pumping rates for each well – to provide the best chance for containment to be complete and overwhelming. This is a critical performance requirement in addition to, and based on, monitoring.

The proposal in the Permit applications for showing “hydraulic containment” is to monitor for and maintain a one foot head difference between pairs of observation and extraction wells on the perimeter of the process zone. Specifically, FCI proposes the use of an observation well just outside of each extraction well and measure and compare water level elevations between the two. As with the excess extraction requirement, this situation is necessary but not sufficient. The magnitude of one foot has no basis in terms of general protection or local relevance; neither would a tenth of a foot or ten feet. The problem here again is that location matters. Particle capture analysis shows that the water levels in the extraction wells are not definitive for demonstrating or even indicating hydraulic containment between two extraction wells and that two extraction wells spaced far enough apart and pumped insufficiently cannot prevail against the background groundwater flow and collect the water moving midway between them. This can all occur while meeting the proposed one-foot water-level difference condition.

Depending on location, the situation can arise and potentially be taken advantage of that water escaping from between two downgradient extraction wells can be pulled back and around into one of the two downgradient extraction wells. The potential for this to happen depends again on the location and magnitudes of the pumping and background groundwater flow. This was alluded to in BHP and FCI documents, but not quantified. Particle capture analysis would clearly indicate the development of this situation to the operator and allow the operator the best chance to act so as to make sure that the capture is forced to be complete.

An alternative to simulation that has been proposed for similar circumstances (pump and treat remediation of contaminated groundwater) is to place and monitor groups of three observation (not extraction) wells downgradient and midway between each pair of adjacent downgradient extraction wells and observe the slope of the water levels in a classic "Three-Point Problem". One problem with this idea is that, in an enforcement implementation of this monitoring-only idea, the operator is not allowed to have the area of the three observation wells over-run by the injected/reacted water, reach more ore, and yet still be granted the opportunity to draw it back in. Simulation combined with a lesser amount of monitoring (less than three wells between each pair of adjacent extraction wells) gives the flexibility to track and enforce capture even when water escapes from directly between adjacent outer extraction wells.

The simulation of particle capture will be most beneficial if the model is calibrated in terms of hydraulic conductivity and storage coefficients to field pumping from each and then both of the two wells in question. Frequently updating the calibration with accumulating pumping rate and water-level response data will be even more helpful to the operator.

Models and Heterogeneity

There are two types of models relevant to the consideration of the proposed mining technology – conceptual and numerical (computer). The conceptual model is usually a spoken or written statement about how the ore body is interpreted to respond to the proposed technology. The numerical model turns that conceptual model into a computer-handled representation for the same purpose. The technical discussions of FCI and SWVP have their foundations on their conceptual models of the ore body. The conceptual model is carried into the numerical models used by FCI.

Specifically, there is a substantial amount of disagreement in the record regarding whether the groundwater moving through the fractured rock of the Florence Copper ore body should be thought of as moving in individual fractures or as the equivalent of a porous medium. The two viewpoints are labeled "Discrete Fracture" versus "Equivalent Porous Medium" and my response is that they are both useful. That is, the flow in this ore body is dominantly in fractures, but to try to characterize each of countless fractures in this ore body in characterizing groundwater flow is not necessary in this setting of intensive and pervasive fracturing. This is exactly analogous to the common situation where it is not necessary to characterize the many, tiny, countless pores of a porous medium (e.g., sand) for groundwater flow analyses. I view this inquiry instead as one of the appropriate level of heterogeneity (spatial variability) to be represented in groundwater flow and transport simulations. I have studied this subject in some detail and would point out that porous media, particularly the kind built from sedimentary depositional processes, can have variability as broad as that of purely fractured media, but that this is rarely brought out in studies due to the goals of most practical hydrologic investigations. Identifying zones of extraordinarily low or high K in porous media is just as much a challenge as doing so for fractured media and in either case, typical continuum models can be used to represent the heterogeneity of either type of groundwater system. If fractures are many and densely packed, then they can be lumped as a group for purposes of thinking about or calculating groundwater flow. In this case, the oxide part of the ore body does have many and densely-packed fractures. Given the results of testing to date, the argument against using an equivalent porous medium (also called a continuum) model is not convincing for this ore body and therefore should be dismissed from these deliberations. This means that standard models of groundwater flow, e.g., MODFLOW, TOUGH, FEFLOW, etc. can be effectively used to simulate groundwater flow in this ore body.

The installation and operation of hundreds of “5-Spot” well arrangements (a central injection well and four nearest neighbor wells used for extraction – the PTF will have four of these) in the proposed full-scale operations would uncover unanticipated arrangements of variability in the fracturing density and other characteristics, i.e., heterogeneity. This heterogeneity is more evident in the observed movement of the subsurface fluids than in the distribution of water-level elevations for reasons taught in groundwater science courses that I will not expound on here. The inevitable presence of unforeseen heterogeneity amplifies the need for the operator to have and use recent (hourly to daily) information to assess and adjust pumping rates at individual wells so as to contain the injected and reacted fluids.

I would further point out that there is also reason to identify and work with the heterogeneity that will be found in this ore body through considerable operator diligence so as to effectively recover copper and restore the system by rinsing. That is, heterogeneity is not just an environmental protection/permitting issue, but is also an engineering efficiency issue. For example, if there is a long and concentrated streak of fractures dominating local flow, failure to identify its effects and adjust effectively will lead to excessive processing of a few limited ore volumes and insufficient processing on the remaining ore volumes, which will waste materials, power and time.

The BHP Pilot Test and Lessons Learned for the PTF Permit

The Appellants in the appeal of the APP to the Water Quality Board wrote at length about the value of test operations conducted in this ore body from late 1997 to early 1998 by the previous owners, BHP Copper. They criticized ADEQ for not considering the results of those tests in their deliberations and final granting of the APP. I have reviewed the materials associated with the BHP work from 1997 to 1998, including materials subpoenaed during the Appeal, and have concluded that the testing was in fact very relevant to deliberations of the PTF Permit Application. Based on my review and analysis of those materials, I find that the escape or potential for the escape of the injected/reacted fluids from the operations as a whole during that test was not convincingly shown in the available materials. FCI failed to show through basic technical analysis - particle capture analysis - that it understood how to simulate and recognize both success and failure in hydraulic containment when this technology was applied to this ore body.

During the BHP Pilot Test, dilute sulfuric acid was injected and water was extracted from a grid of wells very similar to the proposed PTF and proposed full-scale operations. The system was run for 90 days and then additional operations continued for several months thereafter.

A model of the 1000 foot by 1000 foot area surrounding the BHP Pilot Test was developed by a consultant to BHP soon after the test, but the water-level elevation results of those model simulations were not provided and no mention of simulating hydraulic containment or particle capture was found. The calibrated hydraulic conductivity (K) distribution was provided without details of its development or the model input files.

In order to show how particle capture analysis should be used for operation of the PTF, I ran a few simplified simulations of groundwater flow based on the BHP Pilot Test conducted in from 1997 to 1998 and plotted the simulated particle capture for those conditions. The purpose of these simulations was only to show the concepts of particle capture and how these concepts are relevant to the proposed mining technology in this ore body. I did not attempt to produce an accurate predictive or analytical tool for this ore body.

I developed a similar MODFLOW2005 model (same 1000 foot by 1000 foot area, but uniform 6.25-foot square cells) and used it to simulate water levels and the paths of water particles in the top half of the ore deposit starting from the injection wells. See Figure 2 for location of grid for this MODFLOW Model. I did not include the overlying basin fill aquifers in this initial modeling. Water leaking down from these aquifers would lead to less drawdown due to pumping at extraction wells than simulated here and therefore the potential for escape between extraction wells found here would be increased.

I imposed a slope to the groundwater levels of 0.002 (two feet of drop for every 1000 feet of lateral distance) directed to the northwest based on the typical values interpreted from monitoring in the ore deposit reported in the Permit Applications.

I used three configurations of K provided in the available information: 1) a uniform K of 0.6 feet per day (ft/d), 2) a distribution of K zones with discrete values varying from 0.01 to 0.85 ft/d from the reported calibrated 1000 ft. x 1000 ft. model, and 3) a streak of K of 9.7 ft/d inset into the otherwise uniform setting of K at 0.6 ft/d running close to and between one line of wells (perhaps from a different BHP model study). I ran a simplification of the pumping rates and locations reported by BHP for a period between early November 1997 and late May 1998. The primary “Pilot Test” was 90 days between early November 1997 and early February 1998.

In these three cases, the distribution of injection and extraction from the BPH Pilot Test resulted in simulated water levels such that the background groundwater flow to the northwest was overwhelmed and flowed inward from the boundaries of the 1000 ft. x 1000 ft. area. The water levels in the observation wells were higher than the water levels in the adjacent extraction wells.

When a uniform value of K was used, the simulated tracks of particles indicate that particles starting at the injection wells can escape from between the enclosing extraction wells for the arrangement of pumping rates used during the BHP operations. However, the pumping pulls such particles back into the extraction wells. See Figure 3 for the simulated particle tracks resulting from the case of using a uniform K to simulate the BHP operations.

When the calibrated K distribution presented by BHP was used, similar results were found; though there was concentrating and spreading of the particle paths caused by heterogeneity between the injection and extraction wells. See Figure 4 for the simulated particle tracks resulting from the case of using the variable, zoned K distribution from BHP to simulate the BHP operations.

When the streak of high K also presented by BHP was used, the short circuiting between wells BHP 5 and BHP 9 simply concentrated nearby particle paths into the streak. This is a more pronounced version of the effect of heterogeneity also seen in parts of the calibrated K distribution results. The results were similar regarding the escape and recapture as noted for the other two cases. See Figure 5 for the simulated particle tracks resulting from the case of using the streak of high K from BHP to simulate the BHP operations.

Two additional simulations were prepared to observe the effects of individual pumping rates. The rates during the official 90-day Pilot Test were extended for a year and then turned off. As extraction is continued, the particles were drawn around and back into the extraction wells. It appears that the observed spikes of low pH and elevated sulfate at some observation wells noted in the data by the Appellants could be explained by travel along the particle tracks similar to those simulated here for the test. There was more than a one foot inward water level difference between the locations of the extraction wells and the observation wells just outside when this escape was occurring. See Figure 6 for the simulated particle tracks resulting from the case of using a uniform K and extending the 90-Day BHP test rates for a year and then turning them off. The water particles not yet drawn into an extraction well when the system is turned off will eventually head away from the test wells with the background groundwater flow.

When the pumping rates for the three downgradient wells were decreased by half and these rates were added to the three upgradient extraction wells, the potential for drawing water back into extraction wells was more evident in that particles proceeded farther down gradient between the extraction wells, but were eventually drawn back in. Again, there was more than a one foot water level difference between the locations of the extraction wells and the adjacent observation wells. See Figure 7 for the simulated particle tracks resulting from the case similar to that of Figure 6, but with half of the pumping at the downgradient extraction wells transferred to the upgradient extraction wells.

The simulations discussed here illustrate the basic technical analysis required to implement the proposed technology. Using the information derived from the BHP work from 1997 to 1998 these simulations indicate how the operator can simulate flow during operations and look for areas where adjusting flow rates will ensure hydraulic capture of injected and reacted fluids. Complete hydraulic containment depends on continued extraction until undesirable chemicals have been chemically depleted in the circulating fluids. Specifically, once the extraction pumping is shut down, the water particles taking arcing trajectories outside of the line of extraction wells will no longer be drawn back in and will proceed down gradient with the background groundwater flow. Leakage down from overlying basin fill aquifers in response to extraction would reduce the ability of extraction wells to overcome the local background groundwater flow, so a more complete model would be more accurate for analyzing this test and for simulating the PTF operations.

The only potential chance for controlling solutions in the subsurface is if the operator has access to and uses recent (hourly to daily) information to assess and adjust pumping rates at individual wells to maintain hydraulic control. That assessment will require simulation to understand the consequences of changing pumping rates in specific wells unless a veritable forest of monitoring wells is installed along the likely flow paths between and around individual extraction wells. The measures proposed in the Permit Application do not provide the operator with the information needed to effectively recognize loss of hydraulic control while there is sufficient time to act by adjusting pumping rates.

The primary Permit condition of excess extraction over injection is necessary but not sufficient for hydraulic containment. The other primary Permit condition of a water level higher in an observation well than in the adjacent pumping well is necessary but not sufficient for hydraulic containment. Assessment of hydraulic containment requires different tools (particle capture analysis) than these and was ignored in a quantitative sense by both the FCI (in its Permit Application) and the Appellants in the Appeal of the APP to the Arizona Water Quality Board. That this fundamental concept has been ignored in the considerable volume of application and appeal materials to date indicates that it may be challenging to make it a foundation for operations protective of the groundwater resources surrounding the Florence Copper Project.

Mining near the Community

Given that the proposed technology is complex and demanding of real-time attention, relevant experience is an obvious indicator of how well it works out in practice. SWVP researched this question of experience with in-situ solution copper mining of undisturbed ore and found that it had not yet been applied commercially in the U.S. and that, where the same technology had been applied commercially in some locations of the northern Rocky Mountains for uranium mining, there were groundwater contamination issues that had not yet been addressed. (I did not investigate the monitoring of the uranium projects, so I cannot confirm those findings.)

There is precedent for copper mining adjacent to the Community: at the ASARCO Sacaton Unit Mine, which operated from 1972 to 1984. This mine is six miles northwest of the Town of Casa Grande and three miles south of the Reservation on the south slopes of the Sacaton Mountains. That mine applied open pit mining methods on one of two small porphyry copper deposits and a deep shaft and horizontal extensions on the other. The mine was officially closed in 1984 and was grandfathered in under the Arizona Environmental Quality Act of 1986 as closed and exempt from APP regulations. A proposal by ASARCO to turn the open pit into a municipal landfill was abandoned in 1987 after substantial local opposition. In the spring of 2009, as part of their federal bankruptcy proceedings, ASARCO agreed to pay $20,000,000 to clean up this 3,000-acre site. This indicates that the precedent for mining near the Community's boundaries had a significant environmental impact.

The primary precedent for the testing of the proposed mining technology is coincidently also close to the Community. Seven miles due west of Casa Grande is the Santa Cruz Joint Venture Operational Research Facility, which tested the proposed technology. President Clinton retracted the initial federal participation in the Joint Venture, but ASARCO and Freeport-McMoRan Copper and Gold continued, using the remaining federal funds to close out the project. In 1997, the facility was operational and recovered copper from the deposit. In 1998, the Joint Venture reported to the State of Arizona that 22 months of operations were completed with 35,000 pounds of copper recovered. This testing is widely discussed in the mining engineering literature and obviously relevant, and yet FCI did not mention it in the Permit discussions. The Joint Venture reported to the State of Arizona that "many technical and environmental goals were achieved". I have not followed up on the testing or environmental performance of this test, but the relevance of its performance to this Permit is obvious and the lack of discussion of it or basic technical analysis of its performance is most disconcerting when assessing if FCI is sufficiently proficient in the proposed technology to implement it safely between the Community and surrounding, growing residential developments.

In summary, my research agrees with that of SWVP, though I also identified the relevant and nearby Santa Cruz Joint Venture project. There are no long-term operations of the proposed technology to show Community leaders how environmental compliance works out in practice for this technology. The concerns of the Community's leaders and their neighbors in Florence for this type of mining so close to their boundaries would be best addressed with demonstrated long-term compliance with environmental laws and permit conditions at other sites.

Sincerely,

Peter A. Mock, Ph.D., R.G., P.H.
President and Principal Scientist
Peter Mock Groundwater Consulting, Inc.
Hydrology, Geology and Environmental Science

REGISTERED GEOLOGIST
CERTIFICATE NO
21614
PETER A. MOCK
Date Signed 4/13/15
ARIZONA, U.S.A.
Expires 9/30/15

AMERICAN INSTITUTE OF HYDROLOGY
Certificate Number
1689
Peter A. Mock
4/13/15
Hydrologist

Attachments: Figure 1 - 7

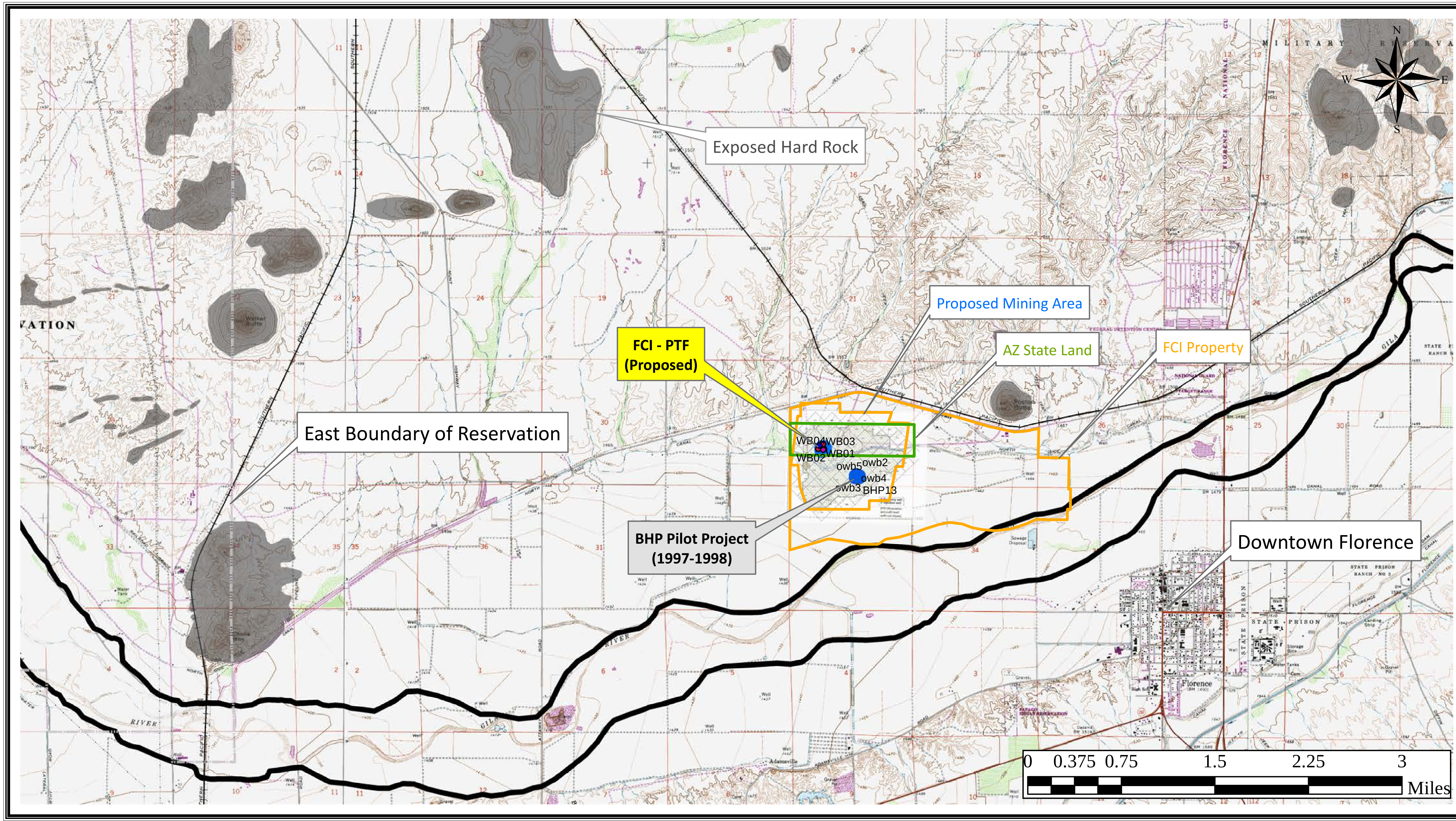


Figure 1 - Florence Copper Project: Location of Proposed Project, Test Sites, and Communities

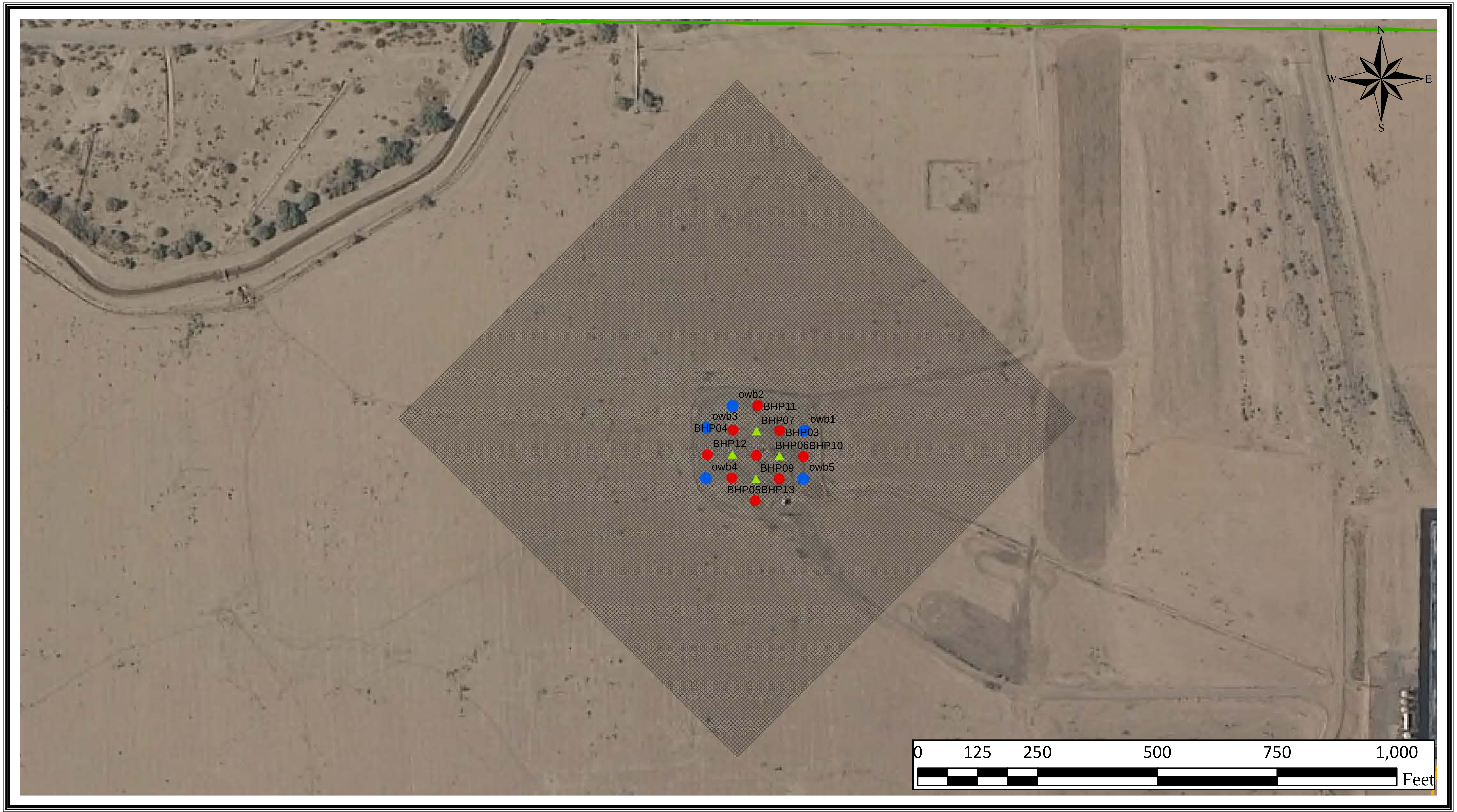


Figure 2 - BHP Pilot Test Wells and MODFLOW Grid Used to Simulate Flow and Particle Tracking

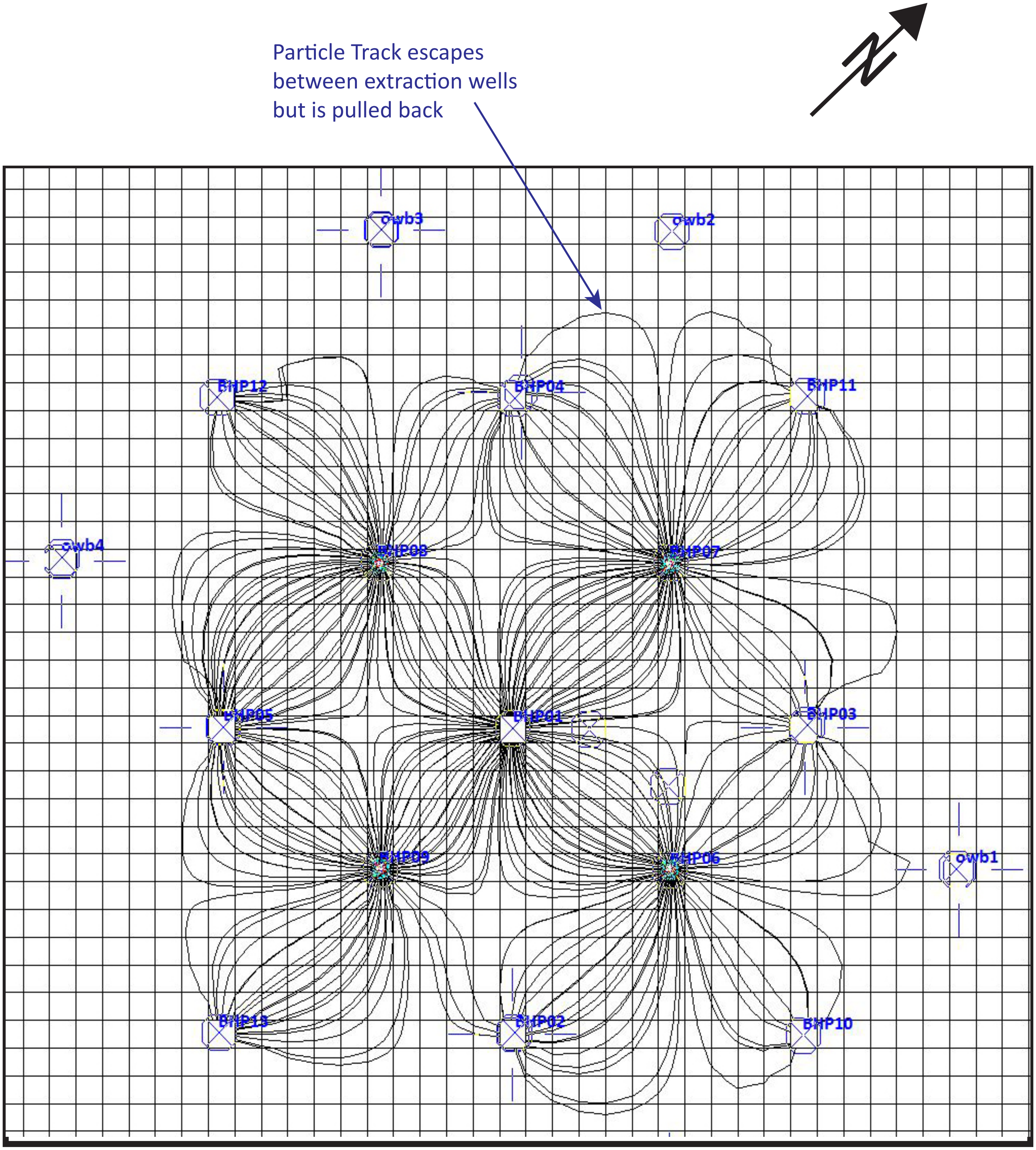


Figure 3 - BHP Test Conditions - Uniform Hydraulic Conductivity - Particle Tracks

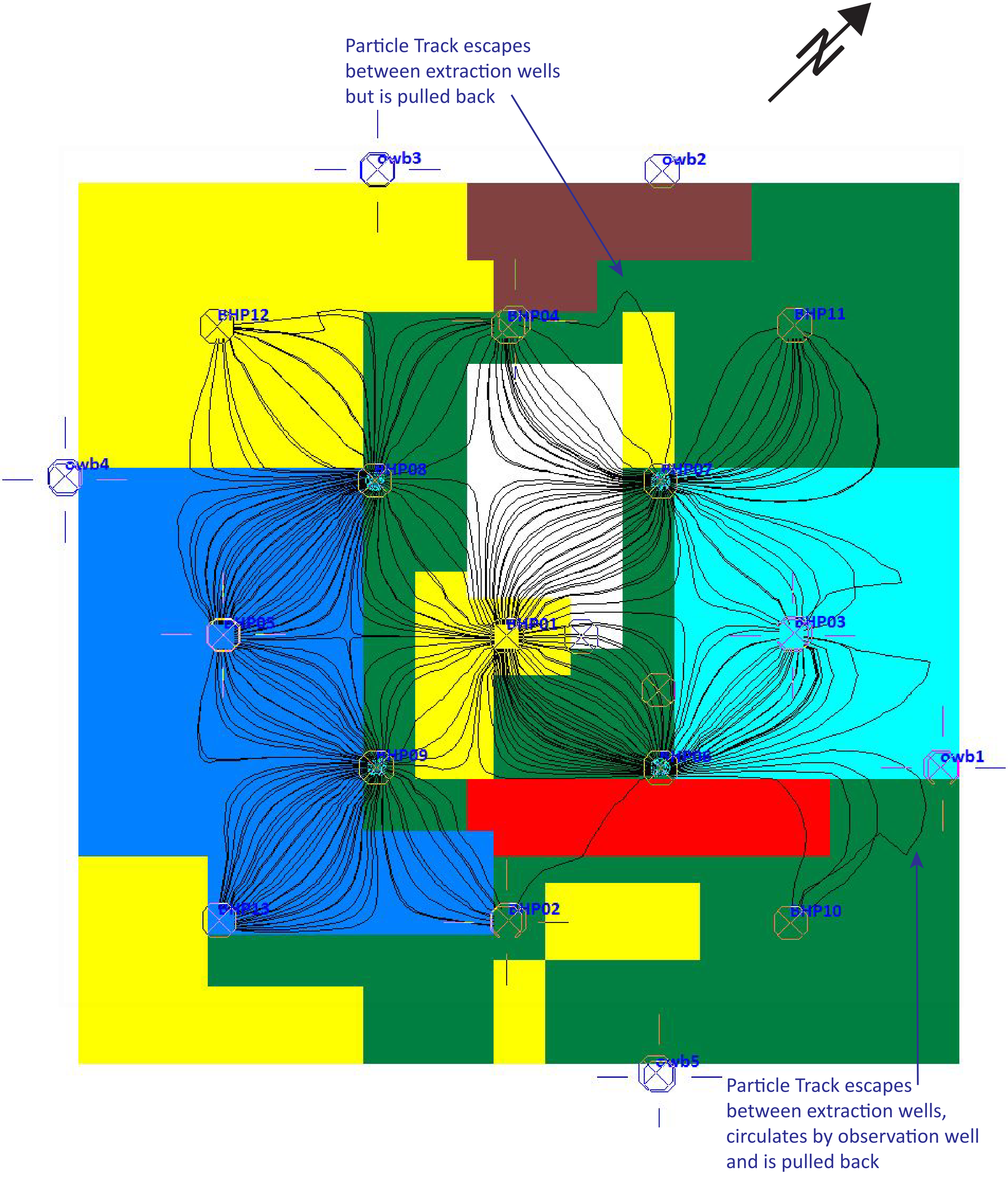


Figure 4 - BHP Test Conditions - Variable/Calibrated Hydraulic Conductivity Particle Tracks

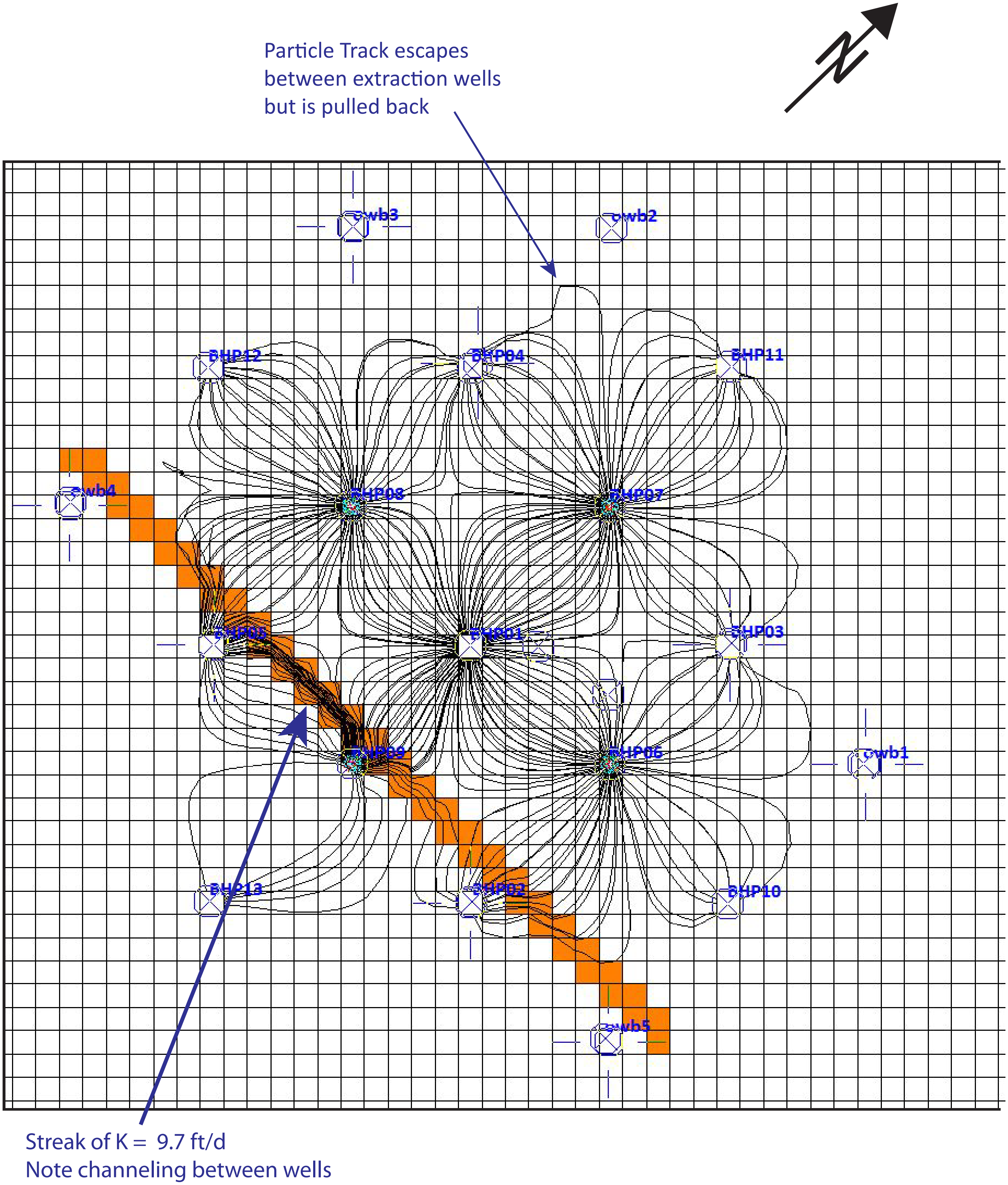
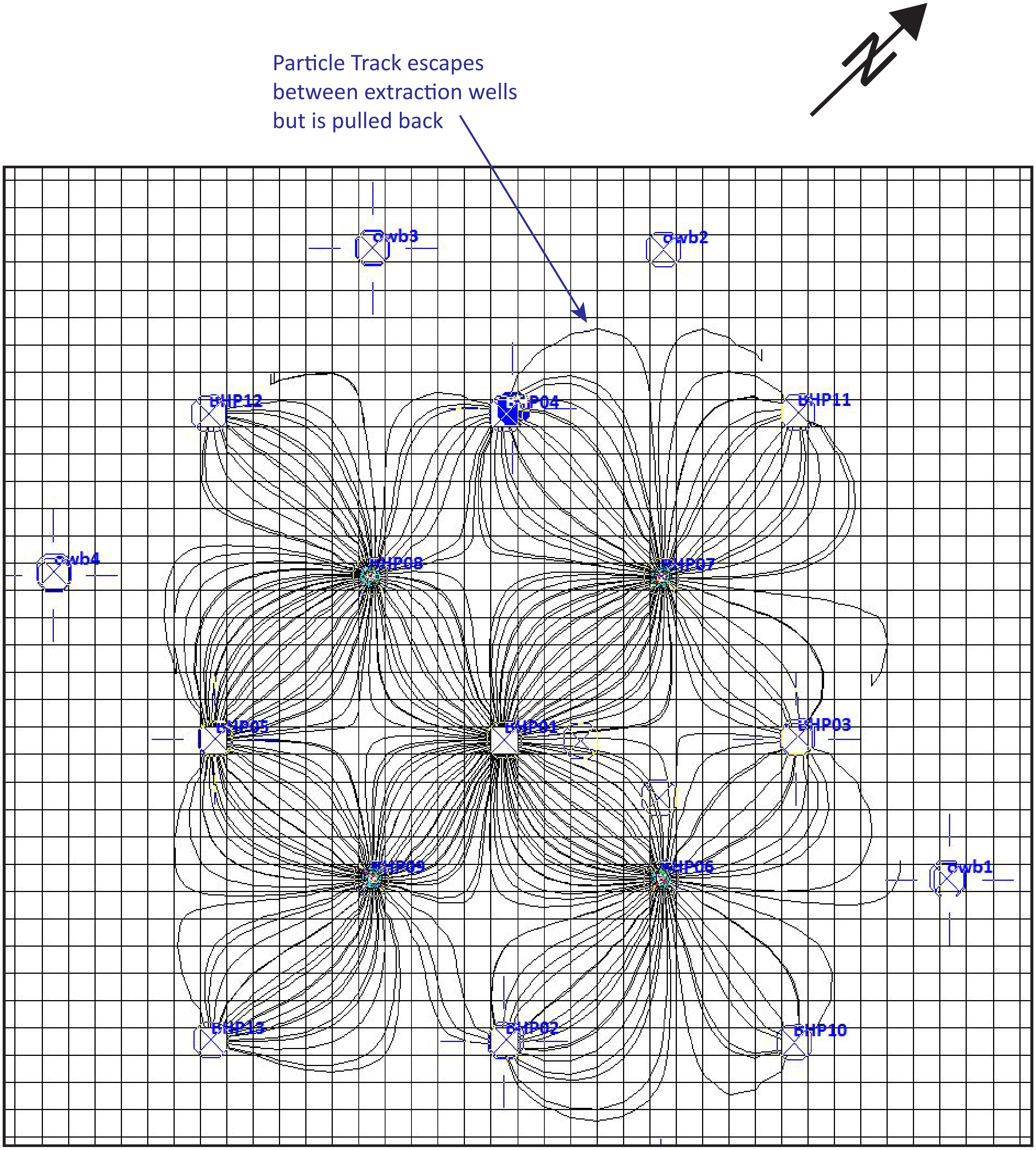
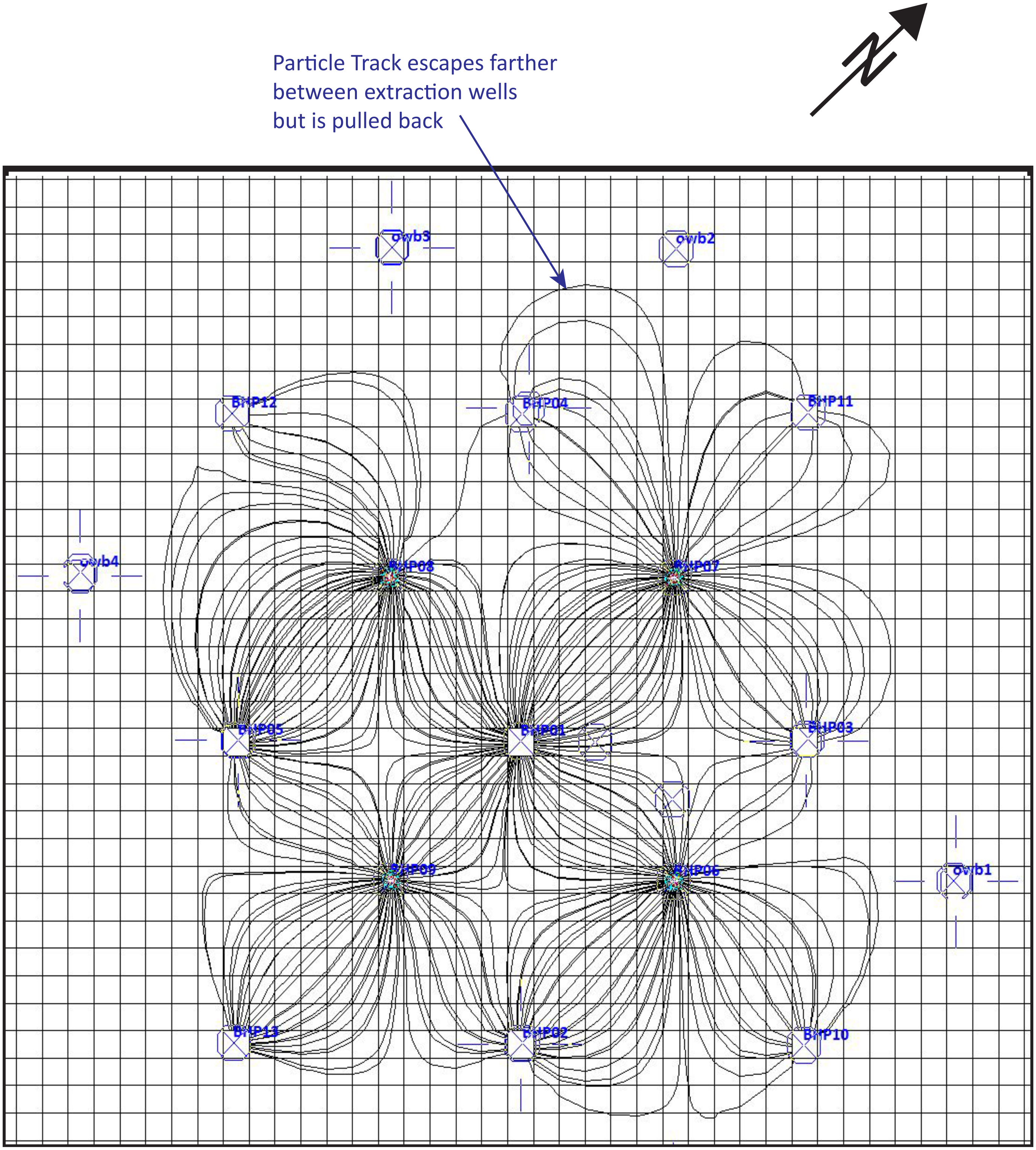


Figure 5 - BHP Test Conditions - Streak in Hydraulic Conductivity - Particle Tracks



Flows at wells are kept at rates used by BHP in “90-day test” (Nov. 97 to Jan. 98)

Figure 6 - One Year On, One Year Off - Uniform Hydraulic Conductivity - Particle Tracks



Flows at wells are kept at rates used by BHP in "90-day test" (Nov. 97 to Jan. 98)
Except to cut rates in half at downgradient (top of picture) extraction wells and
add those amounts to the upgradient (bottom of picture) extraction wells
(Total pumping remains the same for injection and extraction)

Figure 7 - One Year On, One Year Off - Uniform Hydraulic Conductivity - Particle Tracks Move Half of Extraction on Downgradient Side to Upgradient Side