4. Responses to Written Comments Received From The Del Amo Respondents

Preface by EPA:
In this section, EPA summarizes its responses to written comments provided by the Del Amo Respondents. The Del Amo Respondents include Shell Chemical Corporation and Dow Chemical Corporation. The term "Respondents" is used by these corporations to refer to themselves jointly when conducting activities under a Superfund Administrative Order on Consent with respect to the Del Amo Site. Where appropriate, responses are given both within the body of a comment as an issue arises, as well as at the end of an overall comment. The commenter's text is shown in normal text. The summary of EPA's response is given in **bold and back-shaded text**.

The Respondents presented their comments in the format of a report, which is focused on four major issues. Each issue is taken up in turn in an introductory section followed by sections each of which take up each issue in more detail. For efficiency and to limit the need for redundant responses, EPA regrouped some of the Respondents comments (i.e., combined introductory or summary position comments with the specific comments).

The text of the Respondents' comments which required a response from EPA is re-numbered. Introductory comments are numbered 1 through 4. Detailed comments are included as subsections of the corresponding introductory comments (e.g., Comments 1.1 through 1.4 are detailed comments corresponding to the introductory Comment 1). The text of comments which require a response from EPA are otherwise incorporated verbatim.

COMMENT NO. 1:
THE PROPOSED REMEDY FOR TCE SOURCES NEEDS TO BE DESIGNED AND ITS PERFORMANCE UNDERSTOOD BEFORE FINALIZING THE CHLOROBENZENE REMEDY.

Data collected since the October 1995 sampling event indicate continued growth, both vertically and laterally, of TCE and related compound plumes under natural gradients. These findings reveal significant uncertainty regarding the nature and distribution of TCE sources and dissolved phase plumes. Recent increases in concentrations of TCE-plume compounds in the Gage aquifer prompt the need for serious consideration of the presence of DNAPL sources in deeper units. Based on these findings, modeling results, and the proximity of the chlorinated sources and plumes, it is likely that pumping associated with either the proposed TCE or chlorobenzene remedy could exacerbate the distribution of TCE. The Respondents believe that the EPA and parties responsible for the releases of TCE and related compounds into groundwater need to define the sources and extent of these contaminants, establish whether DNAPL is present in the

source areas, and assess how deeply DNAPL may have penetrated. Once this has been completed, the design of the TCE remedy can be completed in such a manner as to not interfere with the chlorobenzene remedy and vice versa.

✍334 EPA Response:

The remedial action for TCE plume does not have to be designed before the decision is "finalized " to select the remedial action in this ROD. The existing data are sufficient to support the selection of the elements of the remedial action that apply to the TCE plume. The basis for this appears in the JGWFS and in EPA's proposed plan. While the JGWFS evaluates differing remedial actions for the three plumes (benzene, chlorobenzene, and TCE), this ROD selects a single, unified remedial action. All components of the remedial action will be designed so as to ensure meeting all of the specifications and provisions in this ROD.

The data presented by the Del Amo Respondents (hereafter, "Respondents"), which can be interpreted to suggest that TCE might move adversely if not addressed as part of the overall remedial action, are consistent with EPA's understanding of TCE (and related chlorinated solvents) contamination at the Joint Site. This is why EPA added remedial action elements for TCE in the JGWFS. The Draft FS dated May 16, 1997, which was authored by the joint parties (Montrose Chemical and the Del Amo Respondents) did not address TCE. The remedial action selected by this ROD will prevent the "exacerbation of the distribution of TCE."

This comment and many of the comments which follow do not sufficiently distinguish between remedial selection and remedial design. What the commenter means by "finalization" is not clear. A clarification of this is therefore important in EPA's initial response here.

The Superfund process includes remedy evaluation and selection, followed by remedial design and action. When the remedial action is selected, it is *not* yet designed. Some of the means that will be used to attain the provisions in the ROD are not yet developed pending the design. The design and optimization of the remedial wellfields for this remedial action (finalized locations of extraction and injection wells, distribution of pumping among wells, etc.) will be performed during the remedial design stage, not during remedial selection. The requirements and provisions of this ROD are to be met and cannot be overridden by the design, however.

EPA agrees with the commenter that additional field data are required to complete the *design* as required by this ROD. Some of the necessary data pertain to refining the distribution and sources of TCE and related solvents in the TCE plume, as suggested in the comment. This ROD requires that these data be collected as part of the remedial design phase (see responses to Comments 1.1 through 1.4). These data will allow the design to ensure that TCE will not move adversely in response to any hydraulic extraction that occurs as part of the remedy.

However, EPA does not agree that the remedial *selection* cannot occur prior to collecting this data. The feasibility of the selected remedial alternative is established sufficiently as documented by EPA's proposed plan, the JGWFS, and the administrative record. EPA agrees that remedial design of the remedial action (as a whole, not just for chlorobenzene) depends on additional data; we disagree that remedial selection does.

The commenter suggests that the parties responsible for the TCE contamination near the western border of the former Del Amo plant should collect the data necessary for the remedial design. This ROD does not specify allocations of responsibility for remedial design nor financial liability. Rather, the ROD specifies *what* will be performed and achieved as the remedial action, independent of the question of who will conduct this work.

[The Following Text Taken from Commenter's Section 1]
In the proposed plan the EPA recognizes the significance of chlorinated solvents as an integral aspect of the proposed groundwater remedy. Inclusion of the TCE plumes and the associated sources in the remedy correctly indicates that the TCE plumes are within the hydraulic influence of the proposed chlorobenzene plume remedy, and must be addressed as part of the groundwater remedy. This conclusion is supported by groundwater modeling, which predicts that without countermeasures, the proposed chlorobenzene remedy results in unacceptable excursion of TCE. The principal element of EPA's proposed remedy for the TCE plume is to partially contain the sources of chlorinated solvents[1] by pumping and treating groundwater at low rates in the immediate vicinity of the sources. Additionally, chlorinated solvents present within the capture zone of the chlorobenzene plume reduction remedy will be removed and treated along with the chlorobenzene.

Several technical issues remain to be resolved before this aspect of the remedy can be successfully implemented. First, as stated by EPA, "Additional sampling during remedial design

[1] The term chlorinated solvents as used in this document refers specifically to all chlorinated compounds detected at the Joint Site and surrounding area exclusive of monochlorobenzene (i.e., chlorobenzene) and dichlorobenzene isomers. The use of the term TCE plume in this document to describe chlorinated solvent issues is consistent with EPA's definition in the proposed plan.

will confirm the exact size and nature of the TCE plume in the MBFB Sand for design purposes." (page 35 of the Proposed Plan). The Respondents fully agree and interpret this statement to address both the dissolved TCE plumes and the sources of TCE. Secondly, the EPA recognizes that the design of the TCE source control remedy will be directly tied to this further characterization and for that reason states that "If the data reveal unexpected information, adjustment to the remedy will be proposed and implemented by the EPA, as necessary." (page 35 of the Proposed Plan). Equally important in this regard is to fully understand the influences that the proposed TCE source control well(s) will have on the chlorobenzene remedy and, vice versa, in order to avoid adverse competitive impacts on each remedy element.

✍335 EPA Response:

The commenter refers to the "chlorobenzene remedy." The JGWFS evaluated actions for each of three plumes, and evaluated how such actions might affect each other. However, this ROD selects one remedial action. All of the components of the remedial action will be optimized together in the remedial design phase. Once the remedial action is designed, extraction and injection wells typically serve a primary purpose with respect to one of the three plumes, but may play a role in the action for all three plumes, depending on the location of the wells. EPA therefore interprets the term "chlorobenzene remedy" as an imprecise term which loosely refers to the portion of the remedial action that is primarily targeted toward the chlorobenzene plume.

EPA is well aware of the importance of coordination within the remedial wellfield to ensure that adverse migration of contaminants (whether of TCE, benzene, or chlorobenzene) does not occur. This is why the JGWFS and this ROD include criteria for the development of the wellfield that require the prevention of adverse movements of contaminants or what the comment refers to as "competitive impacts" from the operation of the wellfield on the distribution of all contaminants. EPA also understands the potential need for additional data on the TCE distribution and sources; however, these data are needed for the design of the remedial system rather than for the conceptual evaluations performed in the JGWFS (See last response).

EPA has not specified in this ROD that no adverse migration of contaminants shall occur at all, nor has it specified that the potential for these shall be completely eliminated. While the JGWFS has shown that it should be feasible to adequately limit adverse migration of NAPL or dissolved phase contaminants and still meet remedial action objectives, it is possible that some adverse migration could occur during remedial implementation. This ROD contains provisions for such a possibility, requiring that the remedial design be adjusted to reverse and contain the adverse migration. It is crucial to note that limiting adverse migration of contaminants shall not take preeminence over all other performance

criteria and remedial action objectives of the selected remedial action. Rather, limiting adverse migration shall take place within the context of meeting all such requirements, including but not limited to attaining applicable or relevant and appropriate requirements (ARARs) in a reasonable time frame, and attaining the required rate of reduction in the volume of the chlorobenzene plume outside the containment zone.

The optimization necessary to limit adverse migration as discussed by the commenter can occur in remedial design and still meet all of the remedial objectives and specifications in this ROD. The remedial design may not violate the provisions of this ROD.

Groundwater modeling results definitively show that without corrective measures, the chlorobenzene remedy will result in unacceptable vertical and lateral excursion of TCE, contrary to EPA's stated performance requirements.

✍336 EPA Response:

The commenter's statement that groundwater modeling "definitively shows" that TCE migration will be unacceptable without corrective measures is an overstatement and is not supported. We note that the degree of uncertainty associated with TCE simulations is much higher than for benzene and chlorobenzene in the modeling efforts referred to by the commenter. The model does not "definitively" predict the migration of TCE in any reasonable sense of the word "definitive." Nonetheless, as already discussed, EPA does agree with the commenter that the potential for TCE migration should be addressed by the remedial action. EPA included a component of the remedial action to address TCE in the JGWFS specifically because the remedial action components for chlorobenzene and benzene could adversely impact the distribution of TCE in the absence of a containment scenario for TCE. The modeling performed by the potentially responsible parties (PRPs), including the commenter, did not include the TCE remedial action proposed by EPA and the model therefore simulated a "vertical and lateral excursion of TCE" referred to in this comment.

These modeling results are based on a preliminary estimation of the TCE sources and plume which were defined only in a most general sense. The degree of resolution regarding both the location of the sources and the spatial distribution of the dissolved phase plume diminishes with increased depth. Recent data collected since the modeling effort (Dames & Moore, 1998b) show increased TCE concentrations and apparent continued vertical and lateral migration of TCE, including elevated concentrations in the Gage aquifer. These data cast significant uncertainty as to the presence, location, and vertical penetration of chlorinated solvent DNAPL sources. The uncertainties in all units are significant and must be resolved to adequately design the proposed remedy for the TCE plume.

✍337 EPA Response:

EPA fully understands the uncertainties associated with TCE distribution and sources, as repeatedly stated in the JGWFS, and intends to resolve these uncertainties at the remedial design stage, as appropriate.

Additionally, because the TCE sources are within the hydraulic influence of the proposed chlorobenzene pumping wells, TCE source containment by pumping will likely have some effect on the chlorobenzene remedy. The low biodegradability of these chemicals under site conditions, coupled with the local presence of continuing sources in positions upgradient of the Joint Site are principal factors influencing the continued movement of the TCE plume. In light of these conditions, it is imperative that a more thorough understanding of the TCE plume and related source areas be developed prior to implementing any elements of the proposed Joint Site remedy if EPA's stated performance requirements are to be achieved. It is exactly for this reason the "EPA proposes to collect additional confirmatory data on the TCE plume in the remedial design Phase" (page 33 of the Proposed Plan). The Respondents concur with and strongly support this concept; however, the Respondents also believe that a more protective, effective, and efficient remedial response can be achieved by accelerating the acquisition of these additional data in advance of other elements of the proposed Joint Site remedy.

✍338 EPA Response:

EPA concurs that the sources and extent of chlorinated solvents at the Joint Site need to be further assessed prior to completing the design of the Joint Site remedy. The *design* of the remedial action components for the TCE plume, however, does not need to be conducted prior to remedy selection and the evaluation of the feasibility of the overall remedial action, including those components targeting the chlorobenzene and benzene plumes. The existing data are sufficient for the feasibility-study-level evaluations, such as the comparative evaluation of different remedial alternatives. The selected remedy for the dissolved contaminants at the Joint Site, such as the pump-treat-inject approach for the (1) containment of the dissolved contaminants, (2) containment of the chlorobenzene and TCE sources (i.e., DNAPL), and (3) plume reduction/removal of chlorobenzene mass, will not likely change based on the potential findings on TCE distribution and sources. However, as stated in the proposed plan, adjustments to the TCE and chlorobenzene remedies can be proposed and implemented by EPA if the collected data reveal unexpected information.

If the commenter means to suggest that remedial design itself should, in some manner, be phased such that the data are obtained at the proper point in the remedial design process to allow for design completion, then EPA agrees with this comment and will take it under

advisement. EPA does not necessarily agree, however, that all remedial design must wait for the acquisition of this data. The statement that it is "imperative" that a more thorough understanding of the TCE plume and source areas be obtained prior to implementing *any* of the components of the Joint Site remedy may be an overstatement.

COMMENT NO. 1.1: MODELING OF CHLOROBENZENE PUMPING SHOWS A SERIOUS POTENTIAL TO CAUSE ADVERSE MIGRATION OF CHLORINATED SOLVENTS.

Modeling results described below strongly indicate that a delicate balance must be maintained during the chlorobenzene remedy to avoid inducing adverse migration of the TCE plume. This balance is required in a region of the MBFC and Gage where overlying units are known to contain significant concentrations of chlorinated solvents.

✍339 EPA Response:

EPA's understanding of the potential TCE migration is consistent with the results of the conceptual modeling performed by the Respondents. The Draft Joint Groundwater Feasibility Study report prepared by the PRPs, including the commenter, dated May 16, 1997, did not include any remedial measures for TCE in spite of the potential for adverse migration of the TCE plume in the course of the remedial actions that were contemplated in that document. When EPA took over the JGWFS effort in July 1997, this technical gap was identified as a shortcoming of the PRP draft of the feasibility study. Therefore, a remedial action for TCE was included in the EPA-authored JGWFS for the reasons that are pointed out by the Respondents (e.g., the TCE plume is within the hydraulic influence of the pumping wells primarily focused on the chlorobenzene plume).

EPA agrees that the remedial action should have an "optimization" process during and/or after the additional TCE data are collected. (It is not clear, however, that EPA's notion of "optimization" exactly parallels that of the commenter. This is further discussed in EPA's responses to comment 2.) The optimization, however, takes place in the remedial design phase, while the remedial objectives, remedial action (i.e., pump-treat-inject) and the degree of aggressiveness of the remedial action was appropriate to evaluate during the feasibility study. The selection of the final remedy from the technical approach and aggressiveness standpoint does not preclude further optimization of this remedy during the remedial design phase. Based on the findings of the remedial design, the wellfield will be optimized to reduce and/or prevent adverse migration and the competing effects of wells, if necessary (again, see also discussion of "optimization" in response to comment 2).

It is also important to point out that the proposed TI waiver zone in the Gage does not encompass all of the area described above. This is particularly true of the area upgradient of the most probable location of injection wells currently envisioned for the Gage component of the proposed chlorobenzene remedy. Consequently, as configured, the proposed remedy would not contain the TCE plume pulled down into the Gage in this area as a result of chlorobenzene pumping. Therefore, consideration should be given to either expanding the TI waiver zone in this area into the Gage aquifer or optimizing the chlorobenzene plume remedy in order to avoid downward migration of the TCE plume into the Gage. The modeling results clearly show that further definition of the sources and limits of the TCE plume is a prerequisite to designing the remedy, which, in turn, is a prerequisite to finalizing the chlorobenzene remedy. The following discussions provide additional details regarding findings of more recent groundwater monitoring events as they relate to the need to define and understand the TCE plume and its sources.

✍340 EPA Response:

EPA agrees that the potential exists for the TCE plume to migrate to the Gage Aquifer, if mitigating actions are not taken. Additional data required during the remedial design phase will assist in designing the remedial action so that this does not occur. Based only on existing data, the TI waiver zone cannot be justifiably extended to the Gage Aquifer below the benzene or TCE plumes at this time. EPA can implement amendments or other modifications to the selected remedial action in the event that the additional data obtained during remedial design indicate the need for such modifications.

The commenter's statement that the remedial action "as currently configured" would not contain TCE contamination drawn down into the Gage aquifer assumes that this ROD restricts the wellfield used in the modeling scenarios. This is not the case. This ROD contains a provision that the TCE be contained, and so the remedial action does in fact address this issue. If significant movement of TCE to the Gage occurs, then the remedial design will be modified to address this problem.

Once again, EPA does not agree that the chlorobenzene remedy cannot be selected supportably prior to obtaining the data in question about TCE. The comment again states that "designing the remedy" is a prerequisite to "finalizing the remedy." To the extent that "finalizing" implies "selecting," EPA disagrees. As stated, EPA does agree that designing the remedy fully will depend on additional data about TCE.

COMMENT NO. 1.2: WHAT ARE THE DATA THAT INDICATE CONTINUED GROWTH OF THE TCE PLUME?

New groundwater data collected since October 1995 indicate local changes in contaminant concentrations that influence how the groundwater remedy should be implemented. More specifically, these new data report locally increased concentrations of one or more chlorinated solvents in all units in locations that lie within the hydraulic influence of the both the TCE plume remedy and the chlorobenzene plume remedy. These data indicate uncertainty as to the nature and distribution of TCE plume and sources.

✍341 EPA Response:

See responses to Comments 1 and 1.1. The final design of the remedial action will be based on consideration of the data identified above. These data are not inconsistent with the conceptual framework already used in selecting the remedial action. The JGWFS has developed the criteria for the performance of this remedy. The final design of the remedy will be performed at the remedial design stage based on the results of additional data acquisition, including, presumably, the data referred to by the commenter. The design of the remedial action components for the TCE plume will be balanced with respect to all other aspects of the remedial action to limit the adverse migration of contaminants while still meeting all other provisions of this ROD.

COMMENT NO.1.3: WHY ARE ADDITIONAL DATA NECESSARY TO FURTHER DEFINE TCE DISTRIBUTION?

Available data relative to TCE in soil and groundwater are lacking compared to that for benzene and chlorobenzene. Consequently, the level of resolution regarding the lateral and vertical distribution of TCE in both the vadose zone and the saturated zone is insufficient to adequately define contaminant source areas and the resultant dissolved plume to the level required to allow implementation of EPA's proposed remedial responses in a manner consistent with achieving EPA's stated performance requirements. The following sections review the available data and outline the reasons why additional soil and groundwater data for chlorinated compounds are required in advance of proceeding with any of the proposed remedial responses.

✍342 EPA Response:

See responses to Comments 1.1 and 1.2. EPA agrees that additional TCE data are needed and intends to collect additional data during the remedial design phase. The JGWFS develops and evaluates the feasibility of a conceptual TCE remedy, which, according to the criteria for the development of the groundwater scenarios presented in the JGWFS, will prevent adverse migration of TCE. The selected remedial action will also be optimized with respect to the chlorobenzene plume based on findings during the remedial design phase, if needed, so as to provide the best balance among the remedial actions for the TCE plume, the benzene plume, and the chlorobenzene plume.

EPA does not agree that absolutely *all* aspects of this data acquisition necessarily must be completed prior to *any* advancement of the remedial design or action, however.

COMMENT NO. 2:

BENZENE PUMPING SHOULD BE A CONTINGENT REMEDY AND NEEDS TO BE LINKED TO THE PERFORMANCE OF AN OPTIMALLY DESIGNED CHLOROBENZENE REMEDY

The EPA cites uncertainty regarding the migration of benzene as a principle reason for proposing pumping to prevent unwanted movement of benzene. Previous modeling has shown that unwanted movement of benzene could occur if the chlorobenzene remedy is not properly designed. Likewise, modeling has demonstrated that unwanted movement of benzene can be avoided, and improvements in the overall performance of the chlorobenzene plume reduction can be achieved, by optimizing the chlorobenzene pumping and injection wellfield design. Prior to receipt of the June 1998 Proposed Plan, optimization had not been conducted for Alternative 4. Consequently, the Respondents are convinced that **optimization modeling of the chlorobenzene remedy is a critical first step** in the design of the remedy wellfield. As shown by our initial optimization effort included herein, the chlorobenzene remedy can be optimally designed and its performance understood through modeling and/or verification monitoring. The Respondents believe that only after these steps have been completed can the remedy for benzene be properly considered.

✍343 EPA Response:

This comment and the majority of those which follow use the term "optimization." EPA wishes to clarify the use of this term as it is not clear that the commenter's definition parallels EPA's. Optimization is a process that occurs in the remedial design phase. Optimization of a wellfield involves adjusting and testing differing locations of extraction

and injection wells, pump rate distributions, and pumping techniques to maximize the efficiency with which the remedial system will meet the requirements of the ROD. Among other things, the wellfield at the Joint Site should be optimized to limit the potential for adverse migration of contaminants, *while still meeting all other objectives and requirements of the remedial action.* While the JGWFS showed that this was feasible, there will be flexibility to modify the wellfields used in the JGWFS in the remedial design phase.

EPA envisions that optimization for this remedial action will include numerical simulations of the groundwater flow and solute transport using a model. However, the process of simulation will be to a significant extent based on pilot testing and adjustment during installment and operation of actual remedial systems. The existing model of the Joint Site, used in the JGWFS, will be refined and updated based on pilot testing to increase the reliability of the model simulations for the optimization process. This point is crucial because the existing model is not sufficient for the optimization of the remedial system.

In addition, there is a definite limit to the degree of optimization that can be provided by modeling alone. Modeling will be used fully as a tool within the context of and in full view of modeling limitations. However, the design of this remedial action cannot be fully optimized solely by modeling. The commenter, in this comment and many of those which follow, refers almost exclusively to modeling optimization. We stress that some of the limitations and uncertainties that EPA has noted with respect to the JGWFS model will apply to all models. Ultimately, only the actual installation of the system, followed by actual *field* optimization, will ensure that remedial objectives (e.g. containment of a plume) can and will be met.

As stated in our above responses with respect to the TCE plume, optimization modeling (as the commenter refers to it) and verification monitoring will take place during remedial design and remedial action. Limiting the unwanted movement of benzene, within the context of attaining all other remedial objectives, is clearly an objective in this ROD and the entire JGWFS effort. However, EPA cannot agree with the statement by the commenter that only after the remedial design is completed for chlorobenzene can a "remedy for benzene be properly *considered"* [emph added]**. In terms of remedy selection, the remedial action for benzene has been properly considered already. The commenter implies that remedial actions for chlorobenzene must be not only designed but functional before any evaluation of remedial selection issues for the benzene plume is even possible. This is not true. The analyses in the JGWFS properly evaluate actions for the benzene plume in concert with actions for the chlorobenzene plume and TCE plume and this ROD selects remedial actions for the benzene plume.**

The remedial design activities do not represent a re-evaluation of whether the requirements of this ROD shall be met; rather, they are a means to optimize the manner in which they shall be met.

Following the selection of Alternative 4 as the remedy in the Proposed Plan, the Respondents have made an attempt to model the optimization of chlorobenzene plume reduction wellfield. By adding one injection well between the fringe of the benzene plume and the centerline of the chlorobenzene pumping wells in the MBFC and maintaining the same total injection rate, the modeling convincingly shows that the pumping-induced benzene excursion can be completely eliminated. The results reinforce the Respondents' strong conviction that pumping the benzene plume can be avoided with optimization of the chlorobenzene wellfield.

Due to reasons listed below, the Respondents believe that pumping benzene in the MBFC needs to be considered only if modeling and performance monitoring show adverse migration of benzene even after the best efforts of optimization of the chlorobenzene remedy have been carried out. Specific attention should be given to reducing potential vertical migration into the Gage aquifer and to maintaining the natural stability of the benzene plume. Contingent measures can be considered and implemented following the optimization and implementation of the chlorobenzene remedy, should unexpected conditions develop that warrant such actions.

✍344 EPA Response:

EPA takes this opportunity to provide a coherent framework for its response not only to this comment but to many of those which follow.

This and several of the following comments are related to the basic issue of whether to use hydraulic extraction to actively contain the benzene plume in the MBFC Sand. Active containment as it is used here includes using hydraulic extraction, possibly in tandem with aquifer injection, to induce hydraulic changes at some location(s) within the aquifer system to contain the benzene plume in the MBFC Sand. The commenter's stated position is that hydraulic extraction (pumping) should be avoided; that optimization of the wellfield should be undertaken instead with monitoring to see whether the benzene plume in the MBFC Sand stays contained on its own.

We believe that the commenter misrepresents *optimization* and *hydraulic extraction* for the MBFC Sand benzene plume as exclusive alternatives. In fact, the remedial design phase will include optimization of the remedial wellfield *regardless* of whether the benzene plume in the MBFC Sand is actively contained with pumping (see response to last comment regarding "optimization"). The issue therefore is more properly represented as whether hydraulic extraction is to be one of the components of the remedial action being optimized

for the benzene plume in the MBFC Sand. In this ROD, EPA addresses this issue in the affirmative.

With respect to the benzene plume in the MBFC Sand, EPA did consider the commenter's favored option of reliance on intrinsic biodegradation, monitoring, and contingent actions only. However, EPA's evaluation led to the conclusion that the risks of such an option are greater than the risks of actively containing the benzene plume in the MBFC Sand using hydraulic extraction and injection, assuming such containment is properly designed and optimized. This ROD, the proposed plan, and the JGWFS support the basis for this conclusion. It is important to note that the basis accounts for several other factors other than the modeling results themselves. They are briefly mentioned below and in the course of the following responses and the response to comment 2.1. Among the principal elements of this basis are the following:

- **The MBFC Sand and Gage Aquifers are more permeable, and deeper, than the UBF and MBFB Sand, and therefore potential deviations between simulations and reality are more critical (contamination is closer to water actually being used for drinking, has more production potential, and the water has the potential to move more quickly);**

- **The Gage Aquifer is the first significantly-water bearing unit in which the benzene plume does not occur; at the same time, it is much more likely to be used as a drinking water source than is the MBFC Sand (noting that the State of California designates all units at the Joint Site as having potential potable beneficial use);**

- **As suggested by the commenter, vertical migration into the Gage Aquifer is of paramount concern and protection of the Gage Aquifer critical;**

- **The Lower Bellflower Aquitard (LBF) separating the MBFC Sand and the Gage Aquifer is very fine-grained and cannot be effectively monitored;**

- **The movements of contaminants from the MBFC Sand through the LBF into the Gage Aquifer could be influenced by localized phenomena such as preferential flowpaths;**

- **The model used in the JGWFS is not appropriate for modeling vertical contaminant *transport* from the MBFC Sand through the LBF into the Gage Aquifer (see comments which follow on this subject);**

- **No amount of additional modeling "optimization" is likely to overcome the uncertainties in distribution of preferential flow paths with the LBF, which could allow vertical migration of the benzene plume from the MBFC Sand into the Gage Aquifer, and other modeling limitations discussed in the JGWFS;**

- **The vertical transport of benzene into the Gage Aquifer can only be monitored with wells placed in the Gage Aquifer. Therefore, migration of the benzene plume cannot be detected until benzene arrives into the Gage Aquifer. Such arrival would significantly complicate and may even prevent the effectiveness of future remedial actions, which would, in effect, be "after the fact:" contamination would already be in the aquifer and have become entrenched in the low-permeable strata in the LBF.**

Because benzene transport into the Gage cannot be reasonably monitored, cannot be reliably simulated without unacceptable uncertainty, and threatens a more critical aquifer, EPA determined that implementing hydraulic extraction to directly contain the contamination in the MBFC Sand was preferable and carried less risk over the long term than trying to simulate optimizations of injection wells and/or relying solely on intrinsic biodegradation to contain the benzene plume in the MBFC Sand.

As part of its comments, the commenter has submitted the results of new modeling efforts using the JGWFS model, claiming that these efforts provide a limited optimization of the remedial wellfield. The JGWFS modeling effort was sound for feasibility study purposes, but not optimized as a design. Optimization, as discussed in EPA's Response ✍344, above, and in several other responses. Such optimization should include not only modeling, but also adjustment during actual implementation and testing of remedial systems. Optimization shall occur within the context of meeting all requirements put forth in this ROD.

However, for reasons that EPA will expand upon in responses to many of the comments which follow, the JGWFS model, while sound for feasibility study purposes, cannot be used to "optimize" the wellfield with respect to vertical migration of benzene from the MBFC Sand through the LBF into the Gage Aquifer. Therfore, EPA disagrees with the commenter's use of the model for this purpose.

We point out that both hydraulic extraction and injection alter hydraulics and can induce unwanted movements of contaminants if not designed properly. Yet, the commenter's preliminary effort at "optimization" focuses solely on adjusting the locations of injection wells already otherwise in use for chlorobenzene plume reduction, while ignoring extraction wells. The commenter (see following comments) then states that it considers hydraulic extraction in the MBFC Sand to be "high risk" because it may upset a "natural

stability" in the benzene plume, while at the same time attaching no apparent risk to injection. It is not clear why the commenter would want to avoid hydraulic extraction for benzene in the MBFC Sand when injection optimization did not raise such concerns.

A sound, reasonably certain, and effective method of containment of the high concentrations of benzene in the MBFC Sand realistically depends on both extraction and injection, and this is what EPA employs in its selected remedial action for the benzene plume in the MBFC Sand. Containing a plume solely by injection (i.e. creating a hydraulic barrier by creating mounding at injection wells) often is a more complicated and uncertain approach than containing by hydraulic extraction and injection (i.e. capturing contaminants by extraction wells with the subsequent removal of contaminated water). The latter approach is more straightforward and provides greater certainty of containment. This certainty, given the conditions just discussed, is necessary in this case.

. Reasons for the Respondents' position are as follows.

- The benzene plume is currently stable in all major hydrostratigraphic units underlying the Del Amo Site largely as a result of intrinsic biodegradation. This condition is convincingly supported by multiple lines of field and modeling evidence.

✍345 EPA Response:

See responses to Comment 2.1.

- Modeling conducted for the Joint Groundwater Feasibility Study (JGWFS) shows that deliberate care needs to be exercised when locating the chlorobenzene extraction and injection wells in order to prevent unwanted movement of benzene and other chemicals. It is therefore critical to maintain the natural stability of the benzene plume while implementing the chlorobenzene remedy. An unoptimized chlorobenzene remedy could lead to a temporary or permanent disruption in the natural stability of the benzene plume.

✍346 EPA Response:

EPA concurs that it is important to contain the benzene plume while implementing the remedial action, particularly those aspects of the action targeting the chlorobenzene plume. To the extent that the benzene plume displays a natural stability (see responses below to comment 2.1, also), it bodes well for this containment. The criteria for the development of the portion of the wellfield primarily targeting the chlorobenzene plume developed in the

JGWFS require minimizing the adverse effects of pumping on other contaminants at the Joint Site, including benzene. In the case of 700- and 1,400-gpm wellfields, however, additional protective actions (e.g. hybrid containment) are required to ensure the containment of the benzene plume within the TI waiver zone over the long term.

- Results of previous and recent optimization modeling efforts of the chlorobenzene plume reduction wellfields clearly demonstrate that by strategically locating injection wells in the MBFC and Gage, one can eliminate the need for active pumping to contain benzene in the MBFC. Uncertainty regarding the stability of the benzene plume can be reduced by monitoring appropriately located and constructed wells.

✍347 EPA Response:

The commenter is overconfident of the modeling results and fails to adequately consider the limitations and uncertainties of the model when interpreting the simulation results with respect to vertical migration from the MBFC Sand to the Gage Aquifer, as discussed in Section 5 of the JGWFS. The modeling presented by Respondents is not adequate for demonstrating that strategic placement of injection wells alone can prevent benzene migration in the MBFC Sand (see responses to Comments 2.2 through 2.4) or "eliminate the need" for active pumping to contain benzene in the MBFC Sand. Moreover, the commenter's use of the model for such vertical simulations is inappropriate (see responses to comments 2.2 through 2.4).

- Lastly, implementation of the benzene gradient control by counter-pumping in the UBF and MBFB is a difficult challenge that may overshadow any potential benefits to be expected.

✍348 EPA Response:

The statement that the challenge associated with the benzene gradient control wells "may overshadow any potential benefits to be expected " is not clear. Hydraulic extraction is a common way to control hydraulic gradient, including vertical gradient. The proposed gradient control wells will create a localized drawdown in the UBF and MBFB Sand to offset the increase in the vertical component of hydraulic gradient between these units and the MBFC Sand that could otherwise be caused by pumping of the benzene containment well in the MBFC Sand. This gradient control will minimize the potential of increased vertical migration of the benzene plume from the UBF and MBFB Sand into the MBFC Sand. Because flowrates of the gradient control wells will be small (only several gpm), the influence of pumping will be limited to the area in the immediate vicinity of these wells.

Therefore, the adverse impact of these wells on the benzene plume is unlikely. While fully understanding the "challenge" of the benzene gradient control, EPA also believes that this remedial measure is feasible from an engineering perspective.

[The following text taken from commenter's Section 2]
COMMENT NO. 2.1: THE BENZENE PLUME IS CURRENTLY STABLE DUE TO INTRINSIC BIODEGRADATION, A CONDITION THAT SHOULD BE PRESERVED.

The EPA clearly recognizes that "there is significant evidence of intrinsic biodegradation of the benzene plume in the UBF and the MBFB sand" (page 14). The Respondents would like to emphasize that this is equally true for the benzene plume in the MBFC around the Waste Pit Area. The same lines of evidence that the EPA uses to evaluate the UBF and MBFB support this conclusion. These are (pages 14-15 of the Proposed Plan):

- The concentration gradients at the leading edge of the benzene plume are steep;
- The lateral extent of the dissolved plume outside of the NAPL sources is small;
- The benzene plume is much smaller than what would be expected on groundwater velocity and expected retardation in the absence of intrinsic biodegradation; benzene has not migrated far from the NAPL sources despite being in the ground 20-40 years;
- The plume appears to be at steady state and does not appear to be migrating laterally;
- In-situ measurements of geochemical parameters (e.g., dissolved oxygen, nitrate, sulfate, methane, etc.) indicate biological activity that is related to (varies spatially with) the benzene concentration in groundwater;
- Biodegrader organism counts in groundwater indicate greater biological activity inside the benzene plume than outside [of] the benzene plume;
- Computer modeling runs could not be reasonably calibrated without assuming significant biodegradation"
- Owing to strong influence of active intrinsic biodegradation, the Respondents are convinced that the benzene plume is currently stable in all hydrostratigraphic units. The Respondents strongly believe that this stability can and needs to be preserved.

✍349 EPA Response:

EPA agrees that the benzene plume in the MBFC Sand currently appears to be relatively immobile and is significantly affected by the process of intrinsic biodegradation. EPA also agrees with the commenter than many of the factors applying to the MBFB Sand and UBF also appear to apply to the MBFC Sand. However, the conclusion drawn by commenter that the benzene plume in the MBFC Sand is absolutely stable over the extreme long term cannot be made with the degree of confidence the commenter attributes. More important than the "natural stability" of the benzene plume in the MBFC Sand, which assumes long-term stability exists, is that the benzene there remain contained. The implication of the comment is that intrinsic biodegradation is sufficient to maintain this containment. However, in evaluating the effectiveness and appropriateness of a remedial action which relies on intrinsic biodegradation for the MBFC Sand benzene plume, different considerations arise than for the UBF and MBFC Sand. These were discussed in detail in the JGWFS, the proposed plan, and this ROD.

These were among the considerations in the evaluation of the reliability of alternatives in which benzene plume containment in the MBFC Sand is effected solely by intrinsic biodegradation, given long-term pumping of the remedial wellfield targeting chlorobenzene:

1. **In the absence of reliable long-term monitoring data (for at least 10 to 15 years), the hypothesis regarding the stability of the benzene plume is based primarily on the assumptions of the timing of the release of LNAPL sources to the aquifers beneath the Joint Site (i.e., the assumption that the sources were introduced about 30 to 40 years ago). Without this assumption, the observed benzene distribution pattern, as well as the geochemical evidence of biodegradation, is not a proof of plume stability (e.g., the limited extent of the plume could be attributed2:43 PM to a more recent source; and, the presence of biodegradation, by itself, does not necessarily indicate that the plume has reached a stable condition). While EPA has agreed that the plume appears relatively stable and sufficiently so to provide a strong indication of the reliable presence of intrinsic biodegradation, absolute long-term stability is not proven.**

2. **While assumptions regarding the timing of LNAPL releases appear to be reasonable for the UBF and MBFB Sand, the contaminant release into the MBFC Sand at the Waste Pit Area is more uncertain. Several issues are not well understood: (1) the high concentrations of benzene; (2) the anomalous geochemistry of Well SWL0040, and (3) the fact that benzene concentrations in the MBFB Sand (directly above Well SWL0040) are lower than in Well SWL0040, are not well-understood. The Del Amo RI report lists several potential explanations for these phenomena, some of which imply that the timing of release at this location is uncertain and could differ from the other releases at the site (D&M, May 15, 1998). For example, if vertical migration from the MBFB Sand is responsible for high concentrations in the MBFC Sand (one of the explanations presented in the RI report), the timing of the contaminant release can be more recent than the initial introduction of LNAPL to the subsurface. Therefore, a relatively limited extent of dissolved benzene in the MBFC Sand downgradient of the Waste Pit Area can be explained by a recent source rather than plume stability.**

3. **The presence of the laterally extensive low-concentration benzene distribution in the MBFC Sand is not fully understood. If this significant lateral extent of benzene is attributed to the presence of chlorobenzene, which could have increased the benzene mobility in the MBFC Sand, the mobilization of the currently immobile benzene sometime in the future cannot be ruled out.**

4. **Due to the uncertainty associated with the benzene source in the MBFC Sand, modeling of benzene transport and the focused transport calibration (FTC) cannot be solely relied upon for the determination of the transport parameters such as half-life, and demonstration of the future immobility of the benzene plume. While the**

FTC assumed long-term sources for all units, the sources in the MBFC Sand could be more recent than LNAPL sources in the UBF and MBFB Sand. Consequently, the half-life of the benzene plume could be underestimated by the focused transport calibration. This, in turn, could cause the migration of benzene in the MBFC Sand to be underestimated.

5. **The MBFC Sand is deeper and more permeable than the UBF or MBFB Sand. Risks associated with failed containment in this hydrostratigraphic unit are therefore greater.**

6. **The MBFC Sand lies directly above the Lower Bellflower Aquitard (LBF), which cannot be reliably monitored. Contaminants passing through the LBF would enter the Gage Aquifer. By the time monitoring picked up benzene contamination in the Gage Aquifer, benzene would have migrated through the fine-grained LBF and continued contamination in the Gage Aquifer would be inevitable. The Gage Aquifer is more likely to be used for drinking water than the upper water-bearing zones, even though all zones are classified by the State of California as having potential potable beneficial use.**

7. **Movement of the benzene plume in the MBFC Sand, if it does occur, would move it toward the chlorobenzene plume in the MBFC Sand where benzene does not appear to be rapidly biodegrading, and potentially into the Gage Aquifer through extended dissolved transport.**

COMMENT NO. 2.2: MODELING RESULTS AND OBSERVATIONAL DATA SUPPORT THE SOURCE OF BENZENE IN THE MBFC.

The EPA states in the JGWFS (page B-17) that "A significant uncertainty is associated with the source of LNAPL in the MBFC." and that "The high benzene concentrations in the MBFC in this area are likely due to the vertical migration of benzene from the upper units.". The EPA cites general reasons for this. First, the EPA asserts, we believe incorrectly, that there is "no evidence that the water table could have been as deep as the MBFC during the operations at the Del Amo facility." The EPA contends, therefore, that the presence of LNAPL at the depth of the MBFC at the Waste Pit Area is "difficult to explain." The EPA further suggests that uncertainties surrounding the groundwater model simulations preclude using them to accurately represent vertical migration into deeper units. Specifically, the EPA states that the modeling results for vertical transport from the MBFC to the Gage are "associated with such high uncertainty as to be largely unreliable" (page 17 of the Proposed Plan).

To the contrary, the Respondents believe that a continuing, NAPL-like source is present in the MBFC based on review of the following modeling and field data. This conclusion is supported by the demonstrated competence of the flow and transport model used in the analysis. Furthermore, uncertainties regarding this area of the model can best be addressed through monitoring of appropriately located and constructed wells.

✍350 EPA Response:

EPA agrees that the possibility of LNAPL occurrence at the top of the MBFC Sand cannot be completely ruled out, although it is more likely that LNAPL was trapped by the relatively low-permeable sediments of the UBF and MBFB Sand than by more homogeneous sands of the MBFC Sand. EPA refers primarily to the bottom of the MBFC Sand, where SWL0040 is screened, when discussing the low likelihood of LNAPL occurrence in the MBFC Sand. As with other site-specific data, EPA relied primarily on the findings and discussions of the Del Amo RI report for the information on the MBFC Sand benzene plume origin and causes (D&M, May 15, 1998, Section 5.3.3.1). The Del Amo RI report states that submerged LNAPL is only one of several potential explanations of high benzene concentrations in the MBFC Sand near Waste Pit Area. It also states, "LNAPL is unlikely to be present at the base of the MBFC Sand where Well SWL0040 is screened since the water table is unlikely to have been this deep during operation of the plant site. "

Other potential explanations for high-concentration benzene in the MBFC Sand presented in the Del Amo RI report are:

- **Surfactants and/or high TDS concentrations in the contaminant solution may have influenced contaminant mobility in this area.**
- **A dry well or other unknown conduit may exist in the vicinity of SWL0040 by which concentrated contaminant solutions have been introduced directly to the MBFC Sand and or B/C Sand in the past without a significant impact on the overlying zones.**
- **Contamination associated with the Waste Pit Area may have migrated down into the MBFC Sand in some areas when groundwater elevations were lower. Given a higher hydraulic conductivity/lower biodegradation rate for the MBFC Sand, higher VOC concentrations in the MBFC Sand relative to the overlying units downgradient of the Waste Pit Area could result.**

- **A naturally occurring, preferential flow path is locally present through which relatively high concentrations of contaminants associated with the Waste Pit Area enter the MBFC Sand in the vicinity of Well SWL004.**

Additional monitoring wells could provide some insight into the source of contamination in the MBFC Sand, but are just as likely to fail to resolve the issue as to resolve it. It is noted that the TI waiver zone was extended to the MBFC Sand regardless of the resolution of whether there is a NAPL at the bottom of the MBFC Sand. While not ruling out the possibility of a NAPL source, EPA has simply determined that it cannot be concluded with sufficient certainty upon which to base a TI waiver determination.

Why is vertical migration of dissolved benzene a less likely mechanism explaining the MBFC benzene plume?

During the development of the model, it was postulated that there might not be a continuing benzene source present in the MBFC beneath the waste pits. Rather, it was postulated that the current benzene plume in the MBFC may have resulted from vertical migration of dissolved benzene from the overlying units. Numerical simulations were conducted to test this hypothesis. Case BT7H was developed in which continuing benzene (LNAPL) sources at the Waste Pit Area were assigned in the UBF and MBFB only. No continuing benzene source was assigned in the MBFC at the Waste Pit Area. The case was simulated in the same manner as the calibrated transport model (BT7), assuming 40 years of flow and transport under the natural gradient. Figure B-5.53b (modified from Draft JGWFS, as is the case for other Draft JGWFS figures referenced herein) clearly shows that simulated concentrations of benzene in the MBFC are significantly less than observed concentrations. For example, the simulated concentration of benzene in the basal MBFC unit is less than 1 ppb for well SWL0040 where 110000 ppb was detected in the third quarter of 1995. Similarly, at SWL0055, the simulated concentration is less than 100 ppb, compared to an observed concentration of 8800 ppb at the same time. In comparison, the simulated concentrations for BT7, in which continuing sources were assigned in the MBFC at the Waste Pit Area, are in close agreement with measured concentrations (Draft JGWFS Figure B.3.13c). Moreover, attempts to simulate "vertical conduits" of higher permeability in order to get benzene to move vertically worsened the calibration of the flow model (see discussion below). Collectively, these modeling results strongly invalidate the notion that vertical migration of dissolved benzene is solely responsible for the MBFC benzene plume; hence, the Respondents conclude that a continuing benzene source is present in the MBFC.

✍351 EPA Response:

Modeling performed by the Respondents is not adequate to resolve the uncertainty associated with the source of benzene in the MBFC Sand. As discussed in detail below, the sitewide model is not calibrated to simulate a small-scale contaminant migration near the

Waste Pit Area. The model is not refined to provide the resolution necessary to simulate phenomena on the localized scale in question at the waste pits. The model was intended and designed to provide a reasonable comparison of the performance of alternatives on a bulk-flow/transport basis and does not include accommodation for the processes which might be responsible for the high-concentration contamination in the bottom of the MBFC Sand in the benzene plume (at the waste pit area). In addition, the model simulations that are used by the commenter to demonstrate the presence of LNAPL in the MBFC Sand do not include any of the alternate plausible scenarios listed in the RI report (e.g., dry well, preferential flow path, and surfactants). EPA therefore does not consider the modeling results presented in this comment compelling or reliable.

Why is a NAPL-like source of benzene in the MBFC possible?

The MBFB and MBFC sands are merged beneath the Waste Pit Area. The fine-grained mud separating the two units is not present and the merged MBFB/MBFC here behaves as a single groundwater flow unit. The MBFC portion of the merged unit is approximately 50 feet thick, with the top-of-unit and bottom-of-unit depths of approximately 85 feet below ground surface (bgs) and 135 feet bgs, respectively (Draft JGWFS Table B-2.2, Boring SBL 0084). The current depth to first water in this area is between 50 to 55 feet bgs. Thus, the distance between first water and the top of MBFC in this area is on the order of 30 to 35 feet.

Historical data on water table levels dating back to the early to mid 1900s are scant; hence, only general statements regarding historical water table levels during the early operation of the former plant site can be made. Available data from wells completed in deeper units suggest that basin-wide water levels reached historic low levels as early as the mid- to late 1950s (LACFCD wells 794B, 795) to no later than the mid 1960s (LACFCD well 806C). Subsequently, water levels have risen at an approximate rate of 1 foot per year. Therefore, water table levels may have been as much as 35 to 40 feet lower than today, or at a depth of 85 to 95 feet bgs. This places the historical low water table as much as 10 feet below the top of the MBFC. A LNAPL-like source that was likely present at the water table during this historically low water level period may have easily penetrated several or more feet into the saturated sands beneath the water table, particularly if the contaminant accumulations were sufficient (a reasonable assumption). Considering this, the most reasonable conclusion is that an LNAPL-like smear zone extends into the MBFC.

✍352 EPA Response:

EPA agrees that the possibility of LNAPL occurrence at the top of the MBFC Sand cannot be completely ruled out, although it is more likely that LNAPL was trapped by the relatively low-permeable sediments of the UBF and MBFB Sand than by more

homogeneous sands of the MBFC Sand. EPA refers primarily to the bottom of the MBFC Sand, where SWL0040 is screened (see responses above) when referring to the low likelihood of LNAPL occurrence in the MBFC Sand.

Why is the Current Model an Adequate and Appropriate Tool for Predicting Vertical Migration of Contaminants into the Gage?

It is recognized that modeling conducted for the JGWFS, like any other numerical model, is subject to some uncertainties and limitations. In particular, we recognize that the assumption of linear equilibrium sorption may result in an overestimate of contaminant removal rate from groundwater when simulating the effects of pumping. Otherwise, selection of transport parameters was done in a reasonably conservative manner, which has resulted in a model that conservatively predicts plume behavior. Additionally, the model has been calibrated against measured groundwater levels in 209 monitoring wells and piezometers, and against observed concentrations of benzene and chlorobenzene. Furthermore, the model has been tested in a series of sensitivity analyses (Tables B-4.1 and B-4.2, Draft JGWFS). For the indicator chemicals of concern that were simulated (including chlorobenzene, benzene, and TCE/PCE), model uncertainties are primarily associated with TCE/PCE source assumptions.

The Respondents also realize that in general there is less observation data in the deeper units for model validation; however, we disagree with the notion that these modeling results of deeper units are subject to a high degree of uncertainty. In particular, the Respondents disagree with EPA's statement that the modeling results for vertical transport from the MBFC through the LBF to the Gage "are associated with such high uncertainty as to be largely unreliable" (page 17 of the Proposed Plan). On the contrary, calibration results support that the flow and transport model is adequate for the purposes of comparative evaluation of remedial alternatives. The root-mean-squared (RMS) of simulated vs. measured hydraulic heads, and the ratio of RMS to the total head change across the entire model domain, are commonly used to measure the accuracy of calibration of flow models. The smaller the RMS value and ratio of RMS to total head change, the more accurate the model. Of the major water-bearing units modeled, the RMS values are 1.23, 0.36, 0.47, and 0.33 feet for the UBF, MBFB, MBFC, and the Gage, respectively (Figures B-3.11b through B-3.11e). The head changes for these units are approximately 9.1, 5.3, 5.2, and 3.9 feet, respectively. Accordingly, the ratios of RMS to total head change are 14%, 6.8%, 9.0%, and 8.5%. Therefore, the accuracy of the flow calibration is approximately the same for the MBFB, MBFC, and Gage. Note that measured water levels from 41 and 27 monitoring points were used in the calibration in the MBFC and Gage, respectively. The number of data points used for each of these hydrostratigraphic units is sufficient to generate a reliable flow calibration.

In terms of contaminant transport, simulated benzene concentrations generally agree within an order of magnitude with observed values in the MBFC sand and Gage aquifer (Draft JGWFS Figures B-3.13c and B-3.13d). This agreement is better than in the overlying units (Draft

JGWFS Figures B-3.13a and B-3.13b), where observed concentrations are orders of magnitude higher and concentration variations are more drastic. Lastly, sensitivity analyses of the flow and transport model in which the hydraulic conductivity was increased to simulate postulated high vertical permeability conduits resulted in worse comparison with measured water levels as well as excessively larger than observed benzene plumes (Draft JGWFS, Tables B-4-1 and B-4-2).

For these reasons, the Respondents conclude that the calibrated flow and transport model "is a highly useful tool for providing a basis of evaluating the performance of alternatives on a comparative basis" (page 17 of the Proposed Plan), particularly for flow and transport in the MBFC and Gage.

✍353 EPA Response:

EPA concurs that the model of the Joint Site is a "useful tool for providing a basis of evaluating the performance of alternatives on a comparative basis." EPA wishes to emphasize that the modeling effort for the JGWFS at the Joint Site was sound and exemplary in many ways for a feasibility study effort, and that the model is extraordinarily useful for the specific purposes to which it is appropriate. All models have limitations. By discussing modeling limitations, EPA does not discredit the model, but rather elucidates the fact that the model cannot be used for all purposes or to answer all questions.

The comment above refers heavily to the *flow calibration* and the low RMS values between actual and simulated heads in the aquifer system. EPA believes that the flow calibration for the modeling effort in the JGWFS was excellent. Unfortunately, the commenter attempts to use this as a support that the *transport calibration* for the MBFC Sand - LBF - Gage units is accurate and that *transport* simulations are correct. The two do not follow. In fact, a sound calibration for vertical transport of benzene in these three units was not achieved (see discussion, below). This is not a failure of the model as there are rarely sufficient data upon which to base such transport calibrations; however, the limitation must be noted.

Contrary to the comment, the current model is not an adequate and appropriate tool for predicting vertical migration of contaminants into the Gage Aquifer or for optimizing remedial alternatives as ascertained by the commenter. The commenter places too much emphasis on the simulation results and fails to consider the limitations and the uncertainties of the model when interpreting results. Specifically, the model of the Joint Site cannot be used reliably to demonstrate that strategic placing of injection wells can prevent benzene migration into the Gage Aquifer. Consideration is given to the following modeling limitations and uncertainties, among others:

- **As mentioned above, the numerical model of the Joint Site is not appropriate for evaluating vertical migration of benzene into the Gage Aquifer at the Waste Pit Area. In order to reproduce this small-scale migration of benzene, the model has to be refined and calibrated at a very small scale, including calibration for solute transport. The site-wide steady-state flow calibration, while useful for simulating average flow conditions and responses to pumping, is not sufficient for meaningful simulations of the small-scale benzene migration.**

- **The quasi-calibration of solute transport was limited by a moderately successful attempt to reproduce the historic benzene migration at a site-wide scale (the term "quasi" indicates the accuracy of the transport calibration is low relative to the accuracy of the flow calibration). In fact, the model did not reproduce the historic benzene concentrations in the Gage Aquifer (Figure B-3.13d of Appendix B of the JGWFS). Therefore, while the simulation of average benzene migration (primarily lateral) is acceptable for the FS-level comparison of conceptual remedial alternatives on a relative basis, the use of the model for predictive estimates of small-scale vertical migration is not appropriate.**

- **In the FTC, the assumptions regarding the long-term sources were made for all units. As discussed previously, the sources in the MBFC Sand are less certain and could be more recent than LNAPL sources in the UBF and MBFB Sand. Therefore, the FTC could underestimate the half-life of the benzene plume, which in turn could result in the underestimate of the future benzene migration. This underestimation of the benzene migration could be the explanation for why the model did not reproduce the historic benzene concentrations in the Gage Aquifer.**

- **As discussed in Section 5.3.2 of the JGWFS, it is possible that the benzene plume from the Waste Pit Area in the MBFC Sand is contributing to the benzene contamination in the Gage Aquifer (i.e., the observed benzene contamination in the Gage Aquifer could be caused by the downward vertical migration of benzene from the MBFC Sand via uncharacterized contaminant migration pathways in the LBF). These potential migration pathways through the LBF are not incorporated into the current model of the Joint Site because of limitations of the currently available technology to characterize small-scale heterogeneities in the LBF that could facilitate migration of the benzene plume. Therefore, if the observed distribution of benzene in the Gage Aquifer is due to the migration along these potential pathways in the LBF that are not incorporated in the model, the model is not a representative tool for evaluating the future vertical migration of benzene from the MBFC Sand into the Gage Aquifer.**

COMMENT NO. 2.3: UNOPTIMIZED CHLOROBENZENE PLUME REMEDY CAN HAVE SIGNIFICANT ADVERSE IMPACT ON CONTAMINANT MIGRATION.

During model development, the modeling team conducted a number of remedial simulations for pumping and injection of the chlorobenzene plume. Several modeling approaches were considered in an effort to comparatively evaluate the performance of the chlorobenzene wellfields in terms of: (1) isolation and containment of NAPL sources; (2) long-term reduction in the chlorobenzene plume; (3) short-term removal of chlorobenzene mass; and, (4) minimizing disruptive effects on the demonstrated stable benzene plume. Wellfield configurations simulated included: Dual Cell and Centerline Extraction supplemented with Plume Edge Injection, Cross Plume Flow, and Upgradient Injection. Hybrids combining dual-cell and centerline approaches in different hydrostratigraphic units were also attempted. The relative merits of wellfield approaches are summarized in Appendix B of the Draft JGWFS. For each wellfield approach, various locations and pumping rates were also tested in an attempt to increase the overall performance of the pump-and-treat system. These results have been presented to the EPA in the form of working technical memoranda and/or orally during the monthly project meetings.

Results of those intermediate runs have clearly shown that if not optimized, the chlorobenzene wellfield can cause excessive migration of dissolved chlorobenzene itself (Figures 2-1 through 2-3 for chlorobenzene in the MBFB, MBFC, and Gage under the IIIA5 wellfield). Although the total extraction rate was only 550 gpm or approximately 75% of that in Alternative 4, the figures show that unoptimized pumping led to a severe expansion of the Gage plume by as much as 500 feet westerly and southerly due to induced downward migration from the MBFC. Additionally, the poor alignment of injection wells in the MBFC also pushed the contaminant into the MBFB, extending the MBFB plume by over 1200 feet in the southeast direction. Because of the paucity of data on source locations and plume extent for TCE and related compounds, simulations aimed at evaluating the chlorobenzene remedy wellfields on these compounds were not carried out to an adequate level of rigor. However, the impact of the chlorobenzene remedy on TCE and related compounds is expected to be similar to that predicted for chlorobenzene, due to the similarities in sorption and biodegradability.

For comparison, the chlorobenzene distributions under an improved wellfield (IIIA15) are shown in Figures 1-4 through 1-6. A comparison of these with the figures for the IIIA5 wellfield clearly illustrate that optimization of the chlorobenzene remedy is critical in order to avoid unnecessary adverse vertical migration of contaminants from the MBFC into the Gage.

✍354 EPA Response:

EPA's responses here parallel those given with respect to the commenter's earlier comments regarding the TCE plume. EPA agrees with the statement that the chlorobenzene remedy needs to be "optimized" (see discussion of the term "optimization,"

EPA Response ✍334). However, the final optimization of the remedial action, which aims to achieve full compliance with the development criteria presented in the JGWFS, will be performed during the remedial design stage. See **also the responses to Comment 2.2 (i.e., the existing model of the Joint Site can not be reliably used to "optimize" the selected remedy). In fact, optimization requires more than modeling but also adjustments performed in the course of testing, implementation and operation of actual remedial systems.**

COMMENT NO. 2.4: PUMPING BENZENE IN MBFC CAN BE AVOIDED WITH OPTIMIZATION OF CHLOROBENZENE PLUME REDUCTION WELLFIELD

The proposed 700-gpm wellfield for reducing the chlorobenzene plume (Alternative 4) has yet to be designed or optimized (page 43 of the Proposed Plan). In modeling simulations of chlorobenzene pumping effects, the modeling team recognized that some local, minor increases in benzene concentrations were predicted by the model in the MBFC sand, mainly due to vertical migration from the MBFB. However, the modeling runs performed for the JGWFS were not fully optimized with respect to the chlorobenzene wellfield because the team was not certain which alternative would be chosen, and it was agreed upon that the optimization would be carried out in the Remedial Design phase of the project.

The Respondents would like to re-emphasize that benzene pumping proposed by the EPA for containment in the MBFC can be avoided with proper optimization and design of the chlorobenzene remedy. The minor excursion predicted in certain simulation scenarios can be eliminated with strategically located chlorobenzene plume reduction wells, as indicated by comparing results of benzene plume distributions under Alternatives 4 (700 gpm chlorobenzene pumping scenario) and 5 (1400 gpm chlorobenzene pumping scenario) (Draft JGWFS Figures B-5.34c1, B-5.34d1, B-5.45c1, and B-5.45d1). In the former alternative (Draft JGWFS Figures B-5.34c1 and B-5.34d1), a small excursion of 100 ?g/l benzene is predicted in the MBFC extending from the Waste Pit Area toward the centerline of the chlorobenzene extraction wellfield. This excursion occurs as a result of induced vertical migration from the overlying MBFB unit by pumping in the MBFC. In the latter alternative (Draft JGWFS Figures B-5.45c1 and B-5.45d1), in which pumping and injection are double that of Alternative 4, this excursion is effectively eliminated by strategically positioning injection wells between the Waste Pit Area and the centerline extraction wellfield.

The effectiveness of this strategy is more convincingly demonstrated by results of additional modeling performed and described below. Since Alternative 4 was proposed as the remedy in the Proposed Plan, the Respondents have made an attempt to optimize the chlorobenzene plume reduction wellfield associated with this Alternative. The original 700-gpm wellfield (known as Chlorobenzene Plume Reduction 2 in the Final JGWFS) was slightly modified by splitting an

injection well (I7 at a rate of 52 gpm as shown in Table B-5.13, Draft JGWFS[2]) into two wells in the MBFC: well I7A with a rate of 30 gpm at the same location and well I7B with 22 gpm approximately 450 feet northwest of I7A (Figure 2-7). Well I7B was chosen in order to enhance the hydraulic circulation toward chlorobenzene pumping wells P2 and P3, and at the same time to reduce benzene migration away from the Waste Pit Area as well as TCE migration from the Trico site. Note that the total injection rate remains unchanged. In addition, the single well designated for containing the benzene plume in the Waste Pit Area (labeled as BIZ-18 in Table B-5.13, Draft JGWFS) was removed in the optimization simulation. The simulated benzene concentrations in the MBFC1 and MBFC2 after 25 years of operation of this modified 700-gpm wellfield are shown in Figures 2-7 and 2-8. For comparison, earlier results obtained with the original 700-gpm wellfield are shown in Figures B-5.34c2, B-5.34d2, and B-5.38c2 as adapted from the Draft JGWFS. As discussed in the JGWFS, modeling showed that without BIZ-18 benzene concentrations in a small area southwest of the 2-Series Pits would exceed 100 ppb due to vertical migration from the overlying MBFB (Figures B-5.34c2 and B-5.34d2). However, the benzene concentrations in the same area are reduced to be less than 10 ppb within 25 years by the new wellfield (Figures 2-7 and 2-8). This optimized simulation also shows improvement in comparison to the EPA proposed wellfield with BIZ-18 (Figure B-5.38c2). These results clearly demonstrate that the minor benzene excursion induced by chlorobenzene pumping in the MBFC can be effectively eliminated by carefully placing and designing the chlorobenzene plume reduction wellfield, a viewpoint that the Respondents have stressed all along. As in Alternative 4, this wellfield has no adverse impact on benzene distributions in the Gage and MBFB, which for simplicity are not presented herein.

The Respondents are convinced that the benefits from the optimization efforts discussed above, in conjunction with the suggested alternative described below to contain MBFC benzene, will address the EPA's concerns over uncertainty which led to the proposal to actively contain the MBFC benzene plume. Additionally, Section 3 will discuss significant benefits of this more optimized wellfield with respect to remediating chlorobenzene and TCE plumes.

✍355 EPA Response:
Again, as discussed above, optimization, on the one hand, and active containment of the benzene plume in the MBFC Sand, on the other, are not exclusive alternatives. Optimization efforts will occur in remedial design and will be important in ensuring that the benzene plume remains contained for the long-term. In addition, EPA has selected active hydraulic containment of the benzene plume for the MBFC Sand, including hydraulic extraction, in response to uncertainties in long-term containment under the conditions being contemplated for the Joint Site (see discussion above). The modeling does not erase these uncertainties.

2Note that some pumping and injection rates labeled in chlorobenzene and TCE figures for this scenario in the Draft and Final JGWFS are not accurate

In this comment, the commenter has again presented modeling results in an attempt to optimize the remedial action and to show that containment can be achieved for benzene with respect to vertical transport from the MBFC Sand across the LBF to the Gage Aquifer using the existing model. As discussed in responses to previous comments and in Section 5.3.2 of the JGWFS, the current model of the Joint Site is not a reliable tool for evaluating the benzene migration from the MBFC Sand into the Gage Aquifer; therefore, it can not be used for the optimization of the portion of the wellfield targeted to chlorobenzene plume reduction. As discussed in previous responses, given the uncertainties associated with the source of benzene in the MBFC Sand (i.e., the source could be more recent than assumed for transport calibration), the half-life of benzene in the MBFC Sand could be significantly underestimated. In addition, preferential flow pathways in the LBF that could serve as conduits for benzene are not incorporated in the model. Therefore, the results of the existing model simulations cannot be reliably used to demonstrate that strategic placing of injection wells can prevent adverse migration of the benzene plume. EPA agrees, however, that additional optimization could be required during the remedial design following the collection of additional data, including TCE data (see earlier discussion of the definition of optimization, above).

While fully understanding the "challenge" of containing the benzene plume in the MBFC Sand, EPA also believes that the use of hydraulic extraction for controlling the flow and creating an adequate capture zone is more reliable, predictable, and easier to achieve from the implementability standpoint than the use of injection. Section 5.3.2 of the JGWFS further discusses the potential difficulties associated with the injection of treated water as the only means to offset the effects of chlorobenzene pumping on the benzene plume.

COMMENT NO. 3: A REASONABLE AND RELIABLE ALTERNATIVE TO ACTIVE PUMPING TO CONTAIN THE MBFC BENZENE PLUME IS SUGGESTED.

A reliable and feasible alternative exists that increases certainty of containment of the MBFC benzene, does not require countermeasures or additional corrective responses, and uses as its principal components the remedial elements already proposed by the EPA for chlorobenzene. The alternative emphasizes the strategic placement of the chlorobenzene remedy injection and pumping wells. As discussed above, previous and recent modeling results show that the chlorobenzene remedial wellfield can be optimized to: (1) greatly increase groundwater flushing toward the chlorobenzene source isolation area (i.e., the central process area, CPA) and hence accelerate the cleanup of the chlorobenzene plume; (2) increase the certainty for containing the TCE plume; and, (3) prevent disturbing the current stability of the benzene plume. Modeling results further indicate that total optimization of the chlorobenzene remedy will decrease its

overall scope and cost. Lastly, this alternative could be augmented, if necessary, with enhanced biodegradation of the MBFC benzene.

✍356 EPA Response:

While EPA agrees that the portion of the remedial wellfield primarily targeted toward chlorobenzene plume reduction would benefit from additional optimization, this optimization will be performed at the remedial design stage upon collection of additional data, including data on TCE distribution and sources. The "optimization" of the wellfield presented by Respondents as part of this comment was performed using the existing groundwater model. However, the existing model, while appropriate for the relative comparison of conceptual alternatives, is not adequate for optimizing the remedial scenarios. Uncertainties and limitations of the existing model that prevent the use of this model for reliable estimates of benzene migration from the MBFC Sand into the Gage Aquifer are listed in responses to Comment 2.4 and in Sections 5.3.2 and 5.4 of the JGWFS.

The Respondents are convinced this suggested alternative, with wellfield optimization and enhanced biodegradation, if needed, along with proper sequencing of remedial elements, will improve the performance of the overall groundwater remedy. The Respondents anticipate that ongoing groundwater monitoring will continue in the future, and will provide data necessary to verify remedy performance and continued benzene plume stability.

✍357 EPA Response:

See earlier responses. As mentioned above, modeling optimization has limitations. Even after the remedial wellfield is optimized, uncertainties associated with the benzene migration from the MBFC Sand through the LBF into the Gage Aquifer would remain. This, in conjunction with the many factors related to the aquifer system and our inability to monitor or reliably simulate the vertical migration of benzene among these units justifies the hybrid containment of the benzene plume. The optimization referred to is still an investigative/modeling based procedure which has inherent limitations.

In summary, the Respondents support a phased approach having the following sequential steps.

1. TCE source and plume definition
2. TCE source remedy design and performance assessment
3. Chlorobenzene remedy optimization
4. Chlorobenzene remedy final design and performance assessment

5. Benzene remedy design and performance assessment

The Respondents urge the EPA to provide for sufficient flexibility in the ROD so that the final decision regarding MBFC benzene considers each of these steps and the issues, concerns and suggestions summarized in the following sections.

✍358 EPA Response:

See responses to Comment 1.

EPA agrees that further TCE source and plume definition will occur in the remedial design phase, and that optimization efforts will take place at that time for the entire wellfield, addressing all three plumes. EPA does not agree to postpone remedy selection with respect to the benzene plume until actions for the chlorobenzene plume and TCE plume are entirely designed and implemented. This is not necessary; actions for benzene can be evaluated and selected presently. The the ROD will provide enough flexibility for phasing the implementation of the proposed remedy and provisions for collection of the additional TCE data. The proposal provided by the commenter is taken under advisement and has some merit, if not taken too rigidly. The structure of the remedial design efforts need not run solely strictly and serially in the order the commenter suggests, although some aspects may benefit from such an order.

A principal performance requirement proposed by the EPA (the Proposed Plan, page 32) is "to require that the benzene plume remain contained within the TI waiver zone." The Respondents are in agreement with this performance requirement, and believe the data collected indicate, to a high degree of certainty, that this requirement is being met today and would be met in the future provided significant changes to the groundwater flow environment do not occur.

It is recognized by EPA and the Respondents, however, that significant changes to the groundwater flow environment could occur as a result of groundwater pumping associated with the proposed remedy for chlorobenzene plume reduction. For this reason, and the uncertainty expressed by the EPA regarding the ultimate fate of the benzene plume in the MBFC under such pumping, the EPA has proposed active containment of the MBFC benzene plume.

The Respondents wish to suggest an alternative means by which to control the movement of benzene. The alternative comprises three components, the first of which should be an outcome of the performance optimization modeling of the chlorobenzene remedy, which EPA proposes to be conducted during the Remedial Design phase (page 43 of the Proposed Plan). The second component involves monitoring of the remedy performance and benzene plume migration. The

third component takes advantage of and enhances the natural biodegradation of benzene in groundwater, which the EPA agrees is: (1) naturally occurring in groundwater at the site; (2) is an important factor in the observed stability of the UBF-, MBFB-, and MBFC-benzene plumes; and (3) is a proven and highly robust process. The three components of the suggested alternative are:

- Strategically inject pumped water between the chlorobenzene source control area and the fringe of benzene plume in the MBFC, in order to: (1) minimize adverse changes in lateral hydraulic gradient within the MBFC benzene plume; and (2) maximize groundwater flushing toward the chlorobenzene source isolation area (i.e., the CPA); and (3) create a hydraulic barrier to prevent TCE plume migration from the Trico area;

- Installation of properly located and constructed monitoring well(s) to monitor benzene plume migration in the area of modeling uncertainty;

- If necessary, enhancing the natural biodegradation of the benzene, and thereby accelerating the reduction of benzene mass, within the MBFC near the downgradient margin of the TI waiver zone beneath the Waste Pit Area.

The Respondents believe this three-component approach is a feasible and superior means of controlling benzene movement because: (1) it would be reliable and adjustable; (2) it would promote a proven, naturally-occurring, biological process in groundwater; (3) it would accelerate benzene mass reduction; (4) it would offer a greater degree of protection of the Gage and MBFC aquifers from adverse migration of benzene or other co-located chemicals, such as TCE and related compounds; (5) it would be verifiable through monitoring; and (6) it would increase the long-term effectiveness of the performance requirements of the remaining elements of the groundwater remedy proposed by the EPA. If performance modeling and monitoring indicate performance requirements for benzene cannot be met, and if the EPA believed this contingency would bring the remedy into compliance with the performance requirement, then the benzene pumping contingency would be implemented.

The components of the suggested alternative and their advantages over the currently proposed benzene remedy are described below.

✍359 EPA Response:

See response to detailed Comments 3.1 through 3.3.

COMMENT NO. 3.1: WHY INJECTION BETWEEN THE BENZENE AND CHLOROBENZENE PLUMES IN THE MBFC?

The EPA indicates (page 44 of the Proposed Plan) that "The modeling simulations resulted in small movements of benzene toward the chlorobenzene plume under the various pumping rates for chlorobenzene which were simulated. This simulated movement was slight, however it is precisely in the area least desirable for benzene movement. Benzene at this location would be entering the chlorobenzene plume and possibly moving downward into the Gage Aquifer."

The Del Amo Respondents are highly sensitive to the potential adverse movement of benzene and other chemicals, such as chlorinated solvents, caused by the proposed chlorobenzene remedy. In a January 30, 1998 letter to the EPA (attached), the Del Amo Respondents stated that "it is of paramount importance to not allow the remediation of the chlorobenzene plume to upset the current stability of the benzene plume beneath the Waste Pit Area." The Respondents further state "that this naturally occurring balance, which has resulted in containment of the benzene plume beneath the Del Amo Site, must be preserved, especially during pumping of the chlorobenzene plume".

Modeling results show that this goal can be achieved by strategically designing the chlorobenzene plume reduction wellfield. The limited initial optimization simulations conducted so far involved well placement optimization in the MBFC aquifer as well as the Gage aquifer. Strategic placement of injection and extraction wells in both aquifers was carried out so that the performance of the wells was not only complimentary in the goal of plume reduction and minimizing adverse movement of contaminants, but also somewhat redundant. That is, the wells were spaced such that temporary downtime of an injection well (which could happen during maintenance or repair) would not affect the overall hydraulic effect created by the complete system.

Results of Optimization Simulations

The initial optimization runs discussed above included strategic placement of injection wells between the MBFC benzene plume and chlorobenzene (MBFC) pumping wells in order to minimize changes to the lateral hydraulic gradient in the vicinity of the Waste Pit Area. A comparative analysis of the initially optimized 1400 gpm chlorobenzene scenario with the unoptimized 350 gpm scenario shows approximately the same predicted benzene distribution in the MBFC (Draft JGWFS Figures B-5.45d2 and B-5.27c2, respectively). Moreover, the optimized 1400 gpm scenario predicts the elimination of the adverse excursion of 100+ ppb benzene that is shown to occur in the unoptimized 700 gpm scenario predictions (Draft JGWFS Figures B-5.45d2 and B-5.34d2, respectively). Again, it is stressed that the optimized 1400 gpm scenario is 2 to 4 times larger than the unoptimized scenarios documented in the JGWFS, which equates to a significantly larger potential burden on the aquifer hydraulics.

Additionally, as discussed in Section 2 (Figures 2-7 and 2-8), an initial optimization of the 700-gpm wellfield has been modeled following the selection of Alternative 4 in the Proposed Plan. A comparative analysis of the earlier and new modeling results clearly and convincingly shows that optimization holds great promise toward achieving the EPA's performance requirements of no benzene movement beyond the TI Waiver Zone, efficient chlorobenzene removal, and TCE plume containment.

Advantages of Minimizing Adverse Gradient Changes in the MBFC

The Respondents believe that optimization of injection and extraction wells in both the Gage and MBFC aquifers is a feasible and effective means of controlling the adverse migration of benzene in an area that EPA indicates is "precisely in the area least desirable for benzene movement." The new modeling results presented in Figures 2-7 and 2-8 clearly show that strategic placement of chlorobenzene plume reduction wells can provide a great degree of reliability, adjustability, and redundancy in achieving the performance requirements in the Proposed Plan, including the specific controls against adverse movement of benzene in this "least desirable area."

Additionally, strategic injection of pumped water between the fringe of the benzene plume and the centerline of the chlorobenzene pumping wells in this area will help to increase groundwater flushing toward the chlorobenzene source isolation area (i.e., the CPA) and hence accelerate the cleanup of the chlorobenzene plume. Modeling results of the initial wellfield optimization described in the previous section show that such optimization will help to reduce the chlorobenzene plume. A comparison of Figures 3-1 and 3-2 to Figures 5-48 and 5-49 of the Final JGWFS shows that injection at well I7B will help to shrink the chlorobenzene plume in the southwest corner of the Del Amo Site (the panhandle) in the MBFC and Gage. This is due to the establishment of a convergent hydraulic gradient and thus enhanced groundwater flushing toward the chlorobenzene source isolation area (i.e., the Montrose Central Processing Area)[3]. The flushing rates of the modified wellfield are shown in Figures 3-3 and 3-4, which can be compared to those of the original wellfield in Figures 5-46 and 5-47 in the Final JGWFS[4]. This result is consistent with EPA requirements to "Limit adverse migration of existing contamination in ways which may lengthen the remedial action, result in a greater potential risk, or cause spreading of the contamination." (page 5 of the Proposed Plan).

Furthermore, results of the initial optimization wellfield described in Section 2 (Figures 3-5 and 3-6) indicate that there are practically no changes in dissolved TCE/PCE concentrations under

[3] In the initial optimization modeling, a small chlorobenzene concentration, on the order of 70 ppb, was noticed in a small area with a size approximately one-fifth of a model cell around injection well I7B. The results of this simulation indicate that additional optimization is necessary in the remedial design phase.
[4] In the Final JGWFS, the chlorobenzene simulation does not include the single well proposed in Alternative 4 for the benzene plume containment.

this wellfield. This means that this wellfield optimization has no significant adverse impact on the TCE plume given the locations and concentrations of chlorinated sources assumed in the model. In fact, strategic injection in the MBFC benzene plume area in conjunction with the proposed TCE source control measures will very likely create a hydraulic barrier to prevent the TCE plume from migrating from the Trico area. This can be demonstrated by further optimizing the wellfield following adequate characterization of sources of the chlorinated solvents.

✍360 EPA Response:

The commenter here embarks on a foray into remedial design work. EPA providing a response with the caveat that the purpose and intent of the response is not to pre-determine the remedial design process., and this response shall not limit the outcome of the remedial design.

EPA agrees that the chlorobenzene remedial wellfield may need to be optimized in order to minimize the adverse impacts on migration of TCE and benzene. This optimization, however, is a task of remedial design, and will be performed upon collection of additional data, including data on TCE distribution and sources. The existing model, while appropriate for the relative comparison of conceptual alternatives, is not adequate for optimizing the remedial scenarios. Uncertainties and limitations of the existing model, which prevent the use of this model for reliable estimates of benzene migration from the MBFC Sand into the Gage Aquifer are listed in responses to Comment 2.4 and in Section 5.3.2 and 5.4 of the JGWFS. Therefore, the optimization modeling performed by Respondents cannot be incorporated into the JGWFS.

EPA preliminarily agrees with the general concept of strategic injection of pumped water between the fringe of the benzene plume and the centerline of the chlorobenzene pumping wells as suggested by the Respondents, and believe this approach could be considered in the "optimization" phase of the remedy during the remedial design stage. However, for reasons already discussed in response to earlier comments, EPA does not agree that it is appropriate to "avoid" hydraulic extraction to contain the benzene plume in the MBFC Sand, as the commenter suggests. The greater certainty of containment afforded by hydraulic extraction justifies it.

As with the commenter's comments on optimization with respect to the TCE plume, optimization will take place (including potentially the injection just mentioned) *in addition* to the active hydraulic containment of the benzene plume. At the same time, optimization, as the commenter refers to it (i.e. optimization using simulation with numerical model only), has limitations and can only go so far in that it is based on modeling and is a "paper exercise." Given the complexity of physical conditions associated with the vertical transport of benzene in the MBFC Sand, LBF, and the Gage Aquifer at the Waste Pit Area,

modeling optimization is highly unlikely to provide sufficient basis to obviate the need for active hydraulic containment of the benzene plume in the MBFC Sand in this area. Once again, optimization must be performed in the context of actual testing, implementation, and operation of actual remedial systems.

Reliability of Injection for Hydraulic Control

The EPA has indicated to the Respondents that injection for control of adverse plume movement is less reliable than pumping. It is recognized that injection wells generally are more prone to operational difficulties than pumping wells. However, these difficulties are addressed through straightforward engineering solutions, as has been shown by numerous entities throughout the world, which rely upon injection for various gradient control schemes, to create barriers against seawater intrusion, and for various potable water storage schemes.

Injection is a critical component in the successful operation of the proposed chlorobenzene remedy. In order to achieve the proposed performance requirement for chlorobenzene plume reduction, the remedy must substantially rely on the successful design of the injection components of the remedial system. Consequently, it will be necessary to incorporate sufficient engineering safeguards and redundancies as part of the normal design of injection systems for the chlorobenzene remedy, so that prolonged failure of injection wells does not occur. Even in the event of downtime for repair or maintenance, the resulting hydraulic effects should have negligible impact on the overall and long-term performance of an optimally designed pumping/injection system. Done properly, system optimization, such as those steps discussed herein, should not result in added engineering requirements or engineered facilities over that necessary for the chlorobenzene remedy as proposed.

✍361 EPA Response:

EPA concurs that injection is a critical component in the successful operation of the remedial action as it relates to the chlorobenzene plume. EPA does not wish to discredit the value of injection as a means of assisting in meeting remedial goals. However, the injection alone would not likely offset the potential adverse migration of benzene due to the hydraulic extraction primarily targeting the chlorobenzene plume, for the following reasons (also see Section 5.3.2 of the JGWFS):

- **There are fewer injection wells than extraction wells on the eastern flank of the chlorobenzene wellfield, which separates chlorobenzene extraction wells from the benzene plume.**
- **These injection wells have lower individual flowrates than extraction wells.**

- **Because of the fewer amount and lower flowrates of injection wells, these injection wells will not likely provide an adequate hydraulic barrier between extraction wells and the benzene plume.**
- **Groundwater modeling results presented by the commenter in association with these comments did *not* indicate that the hydraulic mound would be created by the "optimized" injection wells sufficient to serve as a barrier between the extraction wells and the benzene plume. In fact, from the water level map provided by the commenter it appears that the change in the simulated degree of benzene excursion is due to a reduction (flattening) of the hydraulic gradient; but the gradient is not reversed and a hydraulic barrier is not created.**
- **Although results of transport modeling indicate a decrease in adverse benzene migration due to "optimized" locations of injection wells, these results cannot be considered reliable due to the numerous uncertainties associated with the solute transport parameters of the model and contaminant migration pathways in the LBF, which have already been extensively discussed in earlier responses.**

Based on the above discussion, the degree of certainty that the containment of the benzene plume could be achieved solely by the "optimized" placing of injection wells is low. The hybrid containment of the benzene plume is required in addition to the optimized injection to offset the adverse impacts of chlorobenzene pumping on the benzene plume. The hybrid containment will also be optimized during the remedial design phase to minimize the impact on the benzene plume in the UBF and MBFB Sand, and on the TCE plume.

COMMENT NO. 3.2: REMEDY PERFORMANCE MONITORING

Once the optimized chlorobenzene remedy has been implemented, performance monitoring would be conducted to evaluate the effectiveness of the system. As part of this monitoring, installation of one or more wells in the area of modeling uncertainty would provide the data necessary to monitor the potential migration of benzene in the MBFC or Gage. Benzene migration monitoring would be conducted in a manner which provides timely warning of benzene migration such that contingent measures, such as enhanced in-situ biodegradation or pumping, could be implemented, thus maintaining the objectives of the Proposed Plan.

✍362 EPA Response:

The MBFC Sand is the deepest relatively permeable unit above the Gage Aquifer that enables the distribution of contamination to be identified, monitored, and contained (i.e., neither monitoring nor hydraulic containment can effectively occur in the intervening LBF). Therefore, the downward vertical migration of benzene from the MBFC Sand could be monitored only in monitoring wells installed in the Gage Aquifer. By the time the benzene plume is detected in the Gage Aquifer, both the LBF and the Gage Aquifer would be contaminated with benzene (see Section 5.3.2. of the JGWFS). The contamination of the Gage Aquifer and LBF could exacerbate the problem to the extent that might render the implementation of countermeasures (such as containment) ineffective and too costly.

COMMENT NO. 3.3: WHY ENHANCE IN-SITU BIODEGRADATION OF MBFC BENZENE?

The EPA states in the Proposed Plan (page 33) that benzene has been "proven to be highly and robustly biodegradable" in the groundwater. This fact and numerous lines of evidence presented Dames & Moore, 1998a have led the EPA to conclude in the Final JGWFS that the benzene plume in the UBF and MBFB is stable as a result of intrinsic biodegradation and other attenuation mechanisms. The EPA does not make a similarly strong statement with regard to stability of the MBFC benzene. Rather, the EPA concludes "In the area of high concentrations near the waste pits, the benzene distribution in the MBFC is in an apparently stable condition (i.e., appears to be essentially immobile), and its lateral extent from the waste pits is relatively small." In addition, the EPA states that the steep concentration gradients characteristic of the downgradient edge of the MBFC benzene plume are "similar to what has been observed in the overlying water table units and the MBFB."

Because biodegradation of the benzene plume is occurring within the UBF and MBFB, reliance on monitored intrinsic biodegradation as a means of containing the benzene plume within the UBF and MBFB is proposed by EPA. However, because of the uncertain potential for inducing movement of the benzene in the MBFC, the EPA has not adopted monitored intrinsic biodegradation as the containment remedy for the MBFC benzene. The EPA has expressed concern that benzene in the relatively permeable MBFC could move sideways or down, beyond the limits of the TI waiver zone, in response to chlorobenzene pumping.

The Respondents share this concern to a certain degree, and have discussed two reliable methods of ensuring the chlorobenzene pumping will not alter the groundwater flow environment so as to cause benzene to move. These are the primary means by which the goals of the EPA can be achieved without sacrificing the performance of chlorobenzene plume reduction. An additional measure of assurance to increase the long-term effectiveness of containment of the MBFC

benzene, and a method which is complementary to the optimization steps described above, is enhancing the biodegradation of the benzene plume in the MBFC.

Enhanced biodegradation of the MBFC benzene can be accomplished with a semi-passive system that involves the introduction of oxygenated and nutrient-enriched water into the MBFC benzene plume. The fluid would be formulated to induce accelerated aerobic biodegradation of the benzene along a broad reaction front as it migrates slowly through the contaminated zone. The chemically compatible fluid would be introduced at a minimal rate so ambient hydraulic gradients would not be significantly altered and unwanted chemical reactions within the MBFC, which could reduce formation permeability or increase contaminant mobility, would be avoided.

While the Respondents believe the chlorobenzene optimization efforts alone will be sufficient to achieve reliable containment of the MBFC benzene, this additional element would provide an additional factor of assurance for the overall benzene remedy in the following ways:

- It would promote a proven, naturally occurring biological process known to be occurring in the MBFC;
- It would accelerate the reduction of benzene mass by bio-chemically destroying the benzene to harmless by-products;
- It would be compatible with and complimentary to the optimization steps described above for the chlorobenzene plume reduction element of the proposed plan;
- It would be adjustable in terms of the rate of fluid introduction and the chemical formulation of the biodegradation-enhancing fluid; and
- It would be verifiable through monitoring.

✍363 EPA Response:

It cannot be concluded that enhancing in-situ biodegradation can be more effective than hydraulic containment for the benzene plume in the MBFC Sand. Numerous factors can adversely affect biodegradation rates and, hence, ultimate containment of MBFC Sand benzene with this process. These factors, many of which can be difficult or impossible to control, include:

- **Effective mass transfer of oxygen and nutrients to the lateral and vertical locations where degradation is required without localized extraction to induce hydraulic gradients**

- **Unplanned and rapid uptake of oxygen through abiotic oxidation of naturally occurring reduced compounds such as ferrous iron or sulfide that lowers the effectiveness of injected fluids at stimulating the growth of benzene-degrading microorganisms**

- **The presence of other factors that act as inhibitors to the metabolic activity or growth of benzene-degrading organisms such as the presence of chlorobenzene or high TDS levels**

- **Ecological factors that may negatively impact the growth and success of benzene-degrading organisms, such as more rapid growth of other microorganisms that consume non-aromatic organic compounds and consume oxygen and nutrients more rapidly, thus depleting these essential compounds before benzene-degrading organisms can obtain them for metabolism and growth**

Therefore, while the overall remedy could benefit from the enhanced biodegradation of benzene, this technology cannot be solely relied upon in lieu of hydraulic containment of the benzene plume in the MBFC Sand.

COMMENT NO. 4: SEPARATE RODS SHOULD BE ISSUED FOR EACH SITE.

EPA views the evaluation of remedial alternatives for the chlorobenzene plume, the TCE plume and the benzene plume to be a single technical problem and has indicated that it anticipates writing a single record of decision (ROD) (page 3 of the Proposed Plan). EPA says that subsequent amendments to the ROD may be issued on either a dual-site or site-specific basis.

Work to date has proceeded under separate orders for the Montrose and Del Amo Sites. Respondents have stated their desire to work with the Montrose Respondents in a cooperative atmosphere to resolve technical issues and facilitate sound and productive decisions. See, for example, letter of C.B. Paine to EPA dated June 20, 1995.

At the same time, Respondents have expressed "concerns regarding the appropriateness of a single ROD which would include a remedy or remedies for what ultimately could be a wide range of disparate remedy scenarios." See letter of C.B. Paine to EPA dated June 20, 1996. Both the Montrose and Del Amo Respondents have discussed these concerns in meetings as well as in correspondence.

EPA recognized these concerns in a letter from J.A. Dhont to F. Bachman and C.B. Paine dated February 21, 1996, stating:

> EPA acknowledges that Montrose and the Del Amo Respondents have had some concerns about "joint FS" documents and a "joint ROD" for groundwater, in particular because you may be apprehensive that one party would somehow become liable for cleaning the entire plume at both sites. Please recall that the ROD does not determine who will perform various portions of the remedy, but rather what the remedy will be.

Nevertheless, adopting a single ROD is likely to produce significant practical and legal obstacles to timely implementation. This includes delay in commencement of those aspects of work pertaining to the Del Amo Site which are independent of the TCE source and plume definition, remedy design and performance assessment, and the chlorobenzene remedy optimization, final design and performance assessment (steps 1 through 5) recommended by these comments. These delays would conflict with the policy expressed in the National Contingency Plan that "Sites should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of total site cleanup." (40 C.F.R. 300.430(a)(2)(A).

Issuing a single ROD, if followed by joint orders, also increases the complexity of enforcement. In particular, issuing a single ROD may reduce the incentive of parties who contributed to the TCE plume to assume burdens commensurate with their responsibility.

There is no technical imperative supporting a decision to issue a single ROD. Optimization modeling demonstrates that with proper wellfield design the chlorobenzene remedy can be conducted without impact on the benzene plume**.** The remedial activities identified for the chlorobenzene and TCE plumes are substantially distinct from those required with respect to the benzene plume, which is stable and falls within the proposed Technical Impracticability (TI) waiver zone. Optimization modeling further shows that, given the existing performance criteria, optimized wellfield design can maintain hydraulic separation of the chlorobenzene and benzene plumes. It is therefore unlikely that contaminant migration between the sites will interfere with achievement of remediation goals. The design of the respective remedies can proceed on a coordinated but generally independent basis once the optimization modeling is completed, subject to further review after the TCE plume is more completely defined. Construction, maintenance and operation can also proceed independently as long as the performance criteria are met, with appropriate coordination and monitoring during the start-up phase.

If performance standards are not met, EPA has authority to amend the ROD accordingly. This can be done without incurring from the onset the disadvantages of a single ROD. EPA's authority to prevent any party from interfering with the implementation of the remedy on another site is well established without the necessity of incorporating multiple sites into a single ROD or order.

✍364 EPA Response:

As cited by the commenter, EPA has been and remains aware of the commenter's sensitivities to the implementation of a single ROD. However, EPA does not agree that the groundwater contamination from the two sites is separable, that a single ROD is the most appropriate, nor that it will delay implementation of the remedial action, as the commenter suggests. The following address several points as made by the commenter, roughly in the order made within the comment.

The commenter states that work to date has proceeded under separate orders for the Montrose and Del Amo Sites. This is true. However, for groundwater, EPA more appropriately would have sought to negotiate a single joint order to effect the JGWFS but did not stop work to do so because, at the time that the joint groundwater effort was initiated, Montrose Chemical and the Del Amo Respondents agreed to undertake the effort voluntarily. This was a calculated risk for EPA. While the joint parties ultimately did complete the modeling effort acceptably, they did not complete an acceptable JGWFS report, necessitating EPA's takeover and completion of the work on that document. Thus, while work did proceed under separate orders, this fact does not lend support for separability of the remedial action.

The commenter cites the letter of C.B. Paine to EPA dated June 20, 1996. This letter, and another letter from Shell Oil Company to EPA dated January 14, 1998, present an argument in favor of EPA's issuing separate RODs for groundwater. EPA responded to these letters in a letter dated February 20, 1998, from Keith Takata of EPA to Rand Shulman , Vice President of Shell Oil, laying out its explanation for why EPA believed that a single ROD was appropriate for groundwater at the Joint Site. EPA did not agree with Shell that a "wide range of remedy scenarios" would be implied by a single ROD. EPA also has explained the appropriateness of using a dual-site approach to groundwater in the Section "Context, Scope and Role of the Remedial Action" of this ROD. The contamination at the sites, and the analysis of and implications associated with possible remedial actions for either of the sites, is inextricably related. While portions of the remedial action could be *implemented* in a separate manner, the evaluation leading to remedy selection cannot.

The commenter does not support the supposition that the single ROD will "produce significant practical and legal obstacles to timely implementation," nor state what specific obstacles the commenter envisions. The commenter appears to believe that a site-specific ROD would be preferable to a dual-site ROD because it would, in the commenter's view, allow the commenter to proceed with remedial designs and actions related only to its site (the Del Amo Site), entirely separate from those for the remainder of the Joint Site. The comment states that a dual-site ROD will delay those aspects of the remedial action

"pertaining to the Del Amo Site which are *independent*" [emph. added] **of the additional data gathering and analysis, and remedial design for the other areas of the remedial action.**

This comment is baffling in that it seems to contradict the majority of earlier comments made by the commenter on EPA's proposed plan, which imply (1) that all design work pertaining to the chlorobenzene and TCE plumes should be performed *prior* to any work on the benzene plume, and (2) that only after such work is completed can a remedy for the benzene plume be "finalized." (We note that EPA disagreed with these points.) These earlier comments would suggest that the commenter agrees that there is a profound interrelation among the various plumes and that action on the benzene plume (or, the "independent, Del-Amo action" referred to by the commenter) will be delayed for technical purposes independent of the nature of the ROD. Yet in this comment the commenter says a dual-site ROD would somehow prevent progress on "independent" design aspects.

As EPA has stated and explained earlier in this ROD, EPA believes that remedy selection is not separable and that the technical evaluations leading to it must be performed in a unified vehicle. While it was appropriate for the JGWFS to evaluate the interrelationships among separate actions for each of three plumes, the remedial design will address all requirements of this ROD as a unified whole. The dual-site ROD does not prevent progress on any aspect of this remedial design; in fact, it enhances and simplifies the requirements that must be met by the design.

The dual-site approach is not inconsistent with the NCP. The dual-site groundwater remedial action selected by this ROD is, in fact, an operable unit of the type described at 40 C.F.R. 300.430(a)(2)(A). Moreover, within the context of the unified remedial design, EPA may create phases to the remedial design and action, if appropriate to expedite the remedial action. The commenter does not identify the activities that it believes are "independent" and therefore might be subject to being expedited. However, to the extent that they may exist, there is no reason that a dual-site ROD would prevent the commenter from negotiating an agreement with EPA for their completion. A wide range of enforcement and settlement options for implementing the remedial action are available regardless of whether a dual-site ROD is employed. The dual-site ROD does not place restrictions on these options and will not prevent consistency with the NCP provision cited by the commenter.

The commenter states that optimization modeling shows that the chlorobenzene remedy can be conducted without impact to the benzene plume and that hydraulic separation can be maintained between the benzene and chlorobenzene plume. The commenter also states that it is unlikely that contaminant migration between the sites will interfere with remediation goals. We disagree that "optimization modeling" has been performed adequately to draw these conclusions. The JGWFS model cannot be stretched to the

extreme that the commenter has used it. EPA agrees and this ROD determines that it should be possible to design a remedial action that limits adverse impacts among the plumes, but this is true only if the design accounts for both the benzene and chlorobenzene plumes in a unified manner. EPA disagrees that modeling or any other analysis has shown that the two plumes mentioned are naturally independent such that designs for each plume can proceed without regard for the other. Any design analysis, whether now or in the future, would have to consider all three plumes and have available the benefits of all previous joint analysis already performed. "Contaminant migration between the sites will be unlikely to interfere with remediation goals" only if the remedial action is designed as a whole. EPA agrees that it is possible that construction and maintenance, and possibly some limited aspects of design, *may* be completed in a separate manner, as determined by EPA during those phases.

In actuality, employing a separate (single-site) ROD approach would introduce far more delay and technical and administrative hardship than does the joint (dual-site) ROD. Significant portions of two single-site RODs for groundwater would be redundant. EPA would have to ensure that all aspects of the two RODs were consistent with one another. The same issues of plume interactions and mutual implications of remedial actions would have to be addressed each of two RODs, even though such issues are, at their core, resolved by a single technical analysis. Having proceeded to the present point under a dual-site approach, the remedy can be selected immediately, whereas creating two consistent separate RODs would require a great deal of time. There would be no administrative or technical benefit to creating two RODs, and EPA is unable to identify the "disadvantages of a single ROD" referred to by the commenter in the last paragraph of the comment.