Tracy Regional Groundwater Management Plan

Submitted to:
City of Tracy

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Abbreviations and Acronyms

Basin	San Joaquin Valley Groundwater Basin
BBID	Byron-Bethany Irrigation District
BCID	Banta-Carbona Irrigation District
bgs	below ground surface
BMOs	basin management objectives
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
City	City of Tracy
CSA	County Service Area
CSD	Community Services District
CVP	Central Valley Project
DCE	dichloroethane
Delta	Sacramento-San Joaquin River Delta
DHS	Department of Health Services
DMC	Delta-Mendota Canal
DPWD	Del Puerto Water District
DWR	California Department of Water Resources
DWSAP	Drinking Water Source and Protection
EHD	Environmental Health Services
ET	evapotranspiration
GAC	GroundwaterAdvisory Committee
GMP	Groundwater Management Plan
gpd/ft	gallons per day per foot
gpm	gallons per minute
LAFCO	Local Agency Formation Commission
LUST	leaking underground storage tank
M&I	municipal and industrial
MCL	maximum contaminant level
mg/L	milligrams per liter
MOU	memorandum of understanding

NBID	Naglee-Burk Irrigation District
NCDC	National Climatic Data Center
NRCS	Natural Resources Conservation Service
PBE	Physical Barrier Effectiveness
PCAs	Potential Contamination Activities
PCE	tetrachloroethylene
ppb	parts per billion
RWQCB	Regional Water Quality Control Board
SCSWSP	South County Surface Water Supply Project
SJCFCWC0D	San Joaquin County Flood Control and Water Conservation District
SLDMWA	San Luis and Delta-Mendota Water Agencies
SOI	sphere of influence
SSJID	South San Joaquin Irrigation District
SSJWSP	South San Joaquin Water Supply Project
SWP	State Water Project
TCE	trichloroethylene
TWSID	The West Side Irrigation District
TDS	total dissolved solids
Tracy Subbasin	Tracy Groundwater Subbasin
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
VOC	volitile organic compound
WHPA	Wellhead Protection Area
WSID	West Stanislaus Irrigation District

Executive Summary

Background

The Tracy Groundwater Subbasin (Tracy Subbasin) lies in San Joaquin, Contra Costa, and Alameda Counties, primarily between the eastern extent of the Diablo Range on the west and the San Joaquin River on the east. The surface area of the subbasin is 345,000 acres.

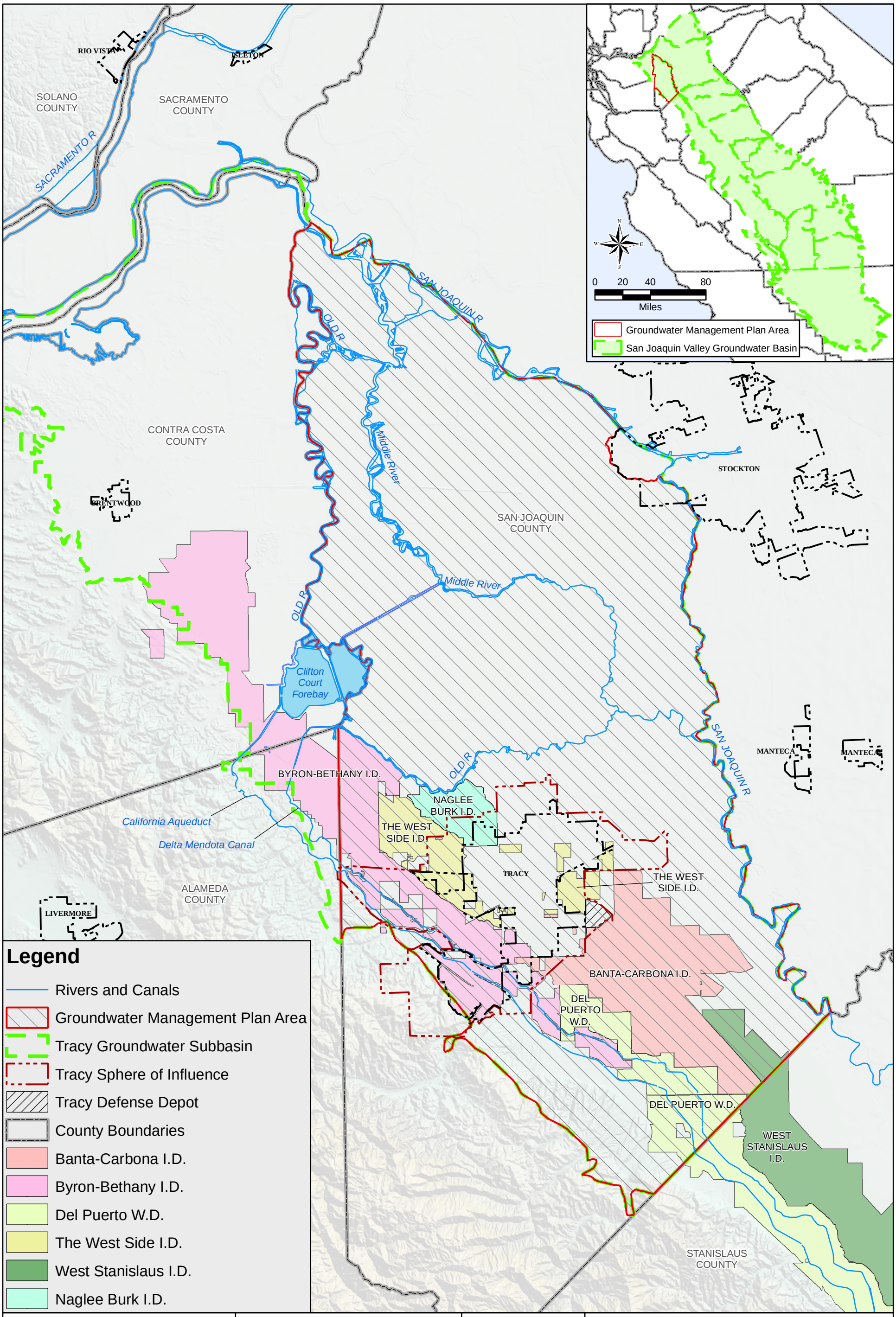
The western, northern and eastern, and southern boundaries are shared with the Pittsburg Plain, Eastern San Joaquin, and Delta-Mendota Groundwater Subbasins, respectively. The major water purveyors in the planning area include the Byron-Bethany Irrigation District (BBID), the Banta-Carbona Irrigation District (BCID), and the City of Tracy (City). Figure ES-1, a map of the subbasin, shows the boundaries of the principal water agencies. These agencies, along with San Joaquin County, formed a Groundwater Advisory Committee (GAC) to facilitate the development of a regional groundwater management plan (GMP) for the Tracy Groundwater Subbasin. The City of Tracy obtained a grant from California Department of Water Resources (DWR) in 2005 to prepare the GMP. Throughout the planning process, other interested parties within the subbasin as well as state agencies have been encouraged to participate in the plan's development.

Planning Area

Irrigated agriculture and urban land uses are the primary developed land uses within the area. The largest jurisdiction within the subbasin is BCID with an irrigated area of approximately 16,000 acres followed by BBID with an irrigated area of approximately 8,000 acres. The City and surrounding urban areas encompass approximately 15,000 acres in the Tracy Subbasin. The regional groundwater plan area encompasses the portion of the Tracy Subbasin within San Joaquin County. Most of the groundwater pumping occurs in the area south of Old River. North of the river, surface water from the Sacramento-San Joaquin Delta is used to meet most of the water demand.

Description of the Regional GMP

This regional GMP has been prepared in accordance with requirements of SB 1938 (California Water Code Section 10750 et seq.), with voluntary components of SB 1938 and AB 3030, and with the suggested components of Bulletin 118.



Tracy Regional Groundwater Management Plan

San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

Tracy Groundwater Subbasin

JANUARY 2007

FIGURE ES.1

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The purpose of this regional GMP is to provide a framework for coordinating groundwater management activities into a set of management objectives and implementing the actions necessary to meet those objectives.

The goal of the regional GMP is to provide a management plan for the use of groundwater within the Tracy Subbasin to ensure the reliability of a long-term water supply that will meet current and future beneficial uses, including agricultural, industrial, and municipal water requirements while protecting the environment. Attaining this goal requires measures that enable the efficient use of groundwater and measures that protect water quality.

The overriding objective of the regional GMP is to improve the regional and local groundwater management through the formulation and implementation of Basin Management Objectives (BMOs).

Regional Priorities

Providing reliable good quality water for the water users in the basin is essential for the economic wellbeing and welfare of the citizens within the Tracy Subbasin. The GMP recognizes that the most effective approach to managing a basin's water resources is to enlist the cooperation of the agencies that share the same groundwater basin. As noted above, the GMP includes a number of regional BMOs that have been agreed upon by the participating agencies. The regional objective of the plan is to foster good stewardship of the resources and to promote wise management of regional resources that responds to regional and local BMOs.

Local Priorities

The overriding local priority for implementation of the GMP is satisfying regional and local water management objectives as they are formulated through the development of BMOs. Through their involvement in the development of the GMP, participating agencies have demonstrated their conviction that the most effective approach to local water management is through regional actions.

Statewide Priorities

Implementation of the GMP will enable the GAC and its member agencies to respond to a range of statewide water management initiatives. Key among these is the increasing emphasis placed on agencies to develop regional solutions to water management problems and to coordinate the conjunctive management of surface water and groundwater for sustainable water supply reliability and water quality in California.

The GMP also frames specific water management projects in the context of a regional water management strategy. Although the plan emphasizes groundwater management, elements of the plan address the use of surface water supplies to meet demands that have previously been

met with groundwater. There is potential for the integration of surface and groundwater resources, and this integration can lead to a more comprehensive management of water supplies and can provide a lucid framework for compliance with state and federal water quality standards.

Regional BMOs

Specific water management strategies developed during the formulation of the regional GMP are expressed by the regional BMOs agreed upon by all of the participating agencies. The following specific regional BMOs are presented in the regional GMP:

Manage Groundwater Levels: Except for some localized areas, groundwater levels in the basin are stable and the basin is generally "full." The increase in urban development is not expected to cause the groundwater table to lower if the growth does not occur in the groundwater recharge areas. This objective is intended to ensure that the overall groundwater levels in the basin are maintained to provide long-term reliable sources of water for the economic well-being of the area. Specific groundwater level management objectives include:

- Maintaining groundwater levels in the confined and unconfined aquifers to avoid long-term overdraft.
- Lowering shallow groundwater levels in the unconfined aquifer to reduce impacts to agricultural and municipal land uses.
- Identifying, mapping, and protecting groundwater recharge areas.
- Identifying additional opportunities to increase water management flexibility through the conjunctive use of surface water and groundwater supplies.

Maintain and Improve Groundwater Quality: Water quality in the basin is generally adequate for agricultural use in the western portion of the subbasin. Water quality becomes worse in the eastern part of the subbasin with high levels of total dissolved solids (TDS) and boron in the groundwater. The water quality generally improves with depth in the unconfined aquifer. In the confined aquifer, water quality generally declines with depth. The best quality water is generally located in the confined aquifer and typically near the upper portion of the confined aquifer. Specific water quality management objectives include:

- Protecting the water quality in the confined aquifer from poorer quality water in the unconfined aquifer by ensuring the proper construction of groundwater wells, including seals to separate the aquifer systems.
- Protecting groundwater from the migration of contamination sources by incorporating available groundwater quality data into groundwater management operations.

- Limiting upwelling of groundwater from the deeper aquifers that contain high concentrations of sulfate.

Protect Against Potential Inelastic Land Subsidence: Historically, no land surface subsidence has been identified within the basin. Given the balanced nature of groundwater storage in the basin, potential future land subsidence is not expected. The specific land subsidence objectives include:

- Managing the groundwater basin to prevent land subsidence.
- Adjusting groundwater management activities if land subsidence resulting from declining groundwater levels is identified.

Protect Against Adverse Impacts to Surface Water Flows: There is little information regarding the relationship and interaction between surface water and groundwater in the Tracy Subbasin. This information is needed to develop an understanding of the implications on the recharge/discharge areas and water quality conditions. GAC member agencies will coordinate with state and federal agencies regarding programs to collect this information. Specific objectives include:

- Monitoring river stage and nearby unconfined groundwater levels.
- Evaluating this information to understand the relationship between surface water flows and groundwater levels at specific locations to determine the effect on groundwater levels and quality.

Groundwater Monitoring and Assessment: Groundwater monitoring provides the data and information needed to make groundwater management decisions. The agencies within the Tracy Subbasin who have participated in monitoring programs are aware of their importance to groundwater management. Current groundwater monitoring efforts include participation by various local districts, San Joaquin County, and DWR. Until the preparation of this GMP, there was no groundwater monitoring plan (Monitoring Plan) for the Tracy Subbasin that coordinated the efforts of the various entities. The Monitoring Plan developed for this GMP is included in Appendix E.

The Monitoring Plan identifies the extent of the existing groundwater monitoring program in the unconfined and confined aquifer systems for both water levels and water quality, and land subsidence. The Monitoring Plan was prepared based on the existing wells monitored by several different agencies in the basin, and provided recommendations for additional monitoring. This plan will be implemented by the GAC member agencies. Specific objectives include:

- Implementing the Monitoring Plan included in Appendix E.

- Discussing with DWR regarding reactivating monitoring at wells where well logs are available.
- Filling the data gaps in the Monitoring Plan with new dedicated multi-completion monitoring wells.

Coordinate with Other Agencies: The City and the other agencies participating in the GAC routinely coordinate on water resources matters within the basin. This coordination can be expanded to include additional water entities that have authority over issues that affect water management activities in the Tracy Subbasin. This expanded forum can be used to assist in the formulation of regional projects and programs for protection and use of subbasin water resources. Specific objectives include:

- Coordinating with water management agencies in San Joaquin County east of the San Joaquin River.
- Coordinating with local agencies with land use planning authority.
- Coordinating with small urban developments fully dependent on groundwater.
- Coordinating with state and federal agencies.

Groundwater Management Measures

The regional BMOs described above have been developed to support groundwater management in the Tracy Subbasin. In particular, these BMOs provide a framework for developing projects that will advance the following groundwater management measures:

Identification and Management of Wellhead Protection Areas: The purpose of wellhead protection is to protect the groundwater used as a public water supply, thereby eliminating the costly treatment otherwise needed to meet relevant drinking water quality standards. Actions associated with the measures include:

- Request that member agencies provide vulnerability summaries from the Drinking Water Source and Protection (DWSAP) to be used for guiding management decisions in the basin.
- Contact groundwater basin managers in other areas of the state for technical advice, effective management practices, and “lessons learned,” regarding establishing wellhead protection areas.

Regulation of the Migration of Contamination and Poor Quality Groundwater: The migration of poor quality groundwater is of primary concern to the City and the irrigation districts, as well as the Tracy Army Depot and the County Service Areas (CSAs) that pump groundwater. Also of concern is the localized contamination of groundwater by industrial

point sources such as dry cleaning facilities, food processors, and the numerous fuel stations throughout the Tracy Subbasin. The following actions will be taken to support this groundwater management measure:

- Develop maps showing the top and bottom and extent of the Corcoran clay.
- Coordinate with the U.S. Geological Survey (USGS), DWR, and San Joaquin County to expand the network of monitoring wells to provide additional water quality data for public supply wells.
- Provide a forum to share all information on mapped contaminant plumes and leaking underground storage tank (LUST) sites.
- Track upcoming regulations on septic systems, agricultural discharges, and other regulatory programs that pertain to water quality degradation.
- Consider a shallow groundwater pumping program to reduce groundwater levels and to create opportunities for controlling migration of poor quality groundwater.

Implementation of Well Construction Policies: The San Joaquin County EHD administers the well permitting program within the Tracy Subbasin. The well construction standards implemented by EHD are consistent with those recommended in State Water Code Section 13801. This section of State Water Code requires that counties, cities, and water agencies to adopt the State Model Well Ordinance as a minimum standard for well construction or a more rigorous standard if desired. The San Joaquin County EHD has enacted well ordinances adopting the *California Well Standards, Bulletin 74-81,* and all supplements for areas of the county. The San Joaquin County EHD staff also issue applications and review construction plans and specifications for wells drilled in the county. The EHD requires and maintains well logs and water well driller reports for constructed wells.

Operating permits for wells utilized for public drinking water are provided through either the DHS or San Joaquin County EHD, depending on the number of service connections. The DHS has jurisdiction over public water system wells with over 200 service connections. Wells that serve public water systems with fewer than 200 service connections fall under the jurisdiction of the county. The following actions will be taken to support this groundwater management measure:

- Ensure that all member agencies are provided a copy of the applicable county well construction ordinance.
- Coordinate with member agencies to provide guidance, as appropriate, on well construction to prevent creating conduits through regionally confining beds.

Administration of Well Abandonment and Destruction Programs: It is believed that there may be many unknown, obsolete, or abandoned water supply and natural gas wells within the Tracy Subbasin. These wells may provide potential locations as a source of contamination between aquifers or from saline water sources, at depth. The following actions should be taken as part of this GMP:

- Ensure that all GAC members are provided a copy of the code and understand the proper destruction procedures and support implementation of these procedures.
- Follow up with GAC members on reported abandoned and destroyed wells to confirm information collected from DWR and receive information on abandoned and destroyed wells to fill gaps in county records.
- Obtain "wildcat" map from California Division of Oil and Gas to ascertain the extent of historic gas well drilling operations in the area because these wells could function as conduits of contamination if not properly destroyed.
- Seek funding to develop and implement a program to assist well owners in the proper destruction of abandoned wells.

Construction and Operation of Recharge, Storage, and Extraction Projects: Various GAC members share responsibility for development and operation of recharge, storage, and extraction projects. The GAC will promote cooperation and sharing of information between the agencies sponsoring water management projects and other member agencies. To the extent feasible, the GAC will also support measures to coordinate development and optimize operation of facilities to improve the basin-wide effectiveness and efficiency of water management. These include the following:

- Encourage sharing of information on project planning, design, and operation among member agencies.
- Promote a coordinated approach toward project development and operation to lower the costs and increase the benefits of water management efforts.
- Seek funding for projects and programs that will contribute to recharge of the groundwater basin.
- Work with the Central Valley RWQCB to permit the City aquifer storage-recovery program.

Public Involvement

The agencies forming the GAC utilize the same groundwater and surface water resources and worked together to formulate this plan to improve their overall management and protection.

Throughout this planning process, other interested agencies and entities within the subbasin were encouraged to participate. The GAC will continue to work with its member agencies and other entities to implement the components of this plan and will engage state and federal agencies in the implementation.

Plan Implementation

The implementation plan presents specific management actions that enable the GAC to meet the BMOs. The purpose of the BMOs and the associated management action is to encourage a balance of surface water and groundwater use that will protect the resources of the basin and maximize the reliable supply of high quality water to meet municipal, agricultural, and industrial demands now and in the future. The BMOs reflect issues that the participating agencies have recognized as potentially jeopardizing the reliability or quality of local water supplies. The management actions are designed to resolve these issues. A list of recommend actions is presented below.

Identification of Natural Recharge Areas: Groundwater recharge from the surface occurs primarily along the western edge of the basin. Recharge due to applied water through this area may be reduced over time because trends in agricultural irrigation practices have reduced deep percolation of applied water. Also, planned urban development in the Tracy Subbasin may impact natural recharge areas. These trends underscore the need to more precisely identify and map the remaining natural recharge areas and to use this mapping to protect important sources of recharge. The objective is to develop specific planning actions that offer varying degrees of protection, depending upon an area's significance as a source of recharge. Types of protection could include programs to educate the public and planning entities about the importance of protecting recharge areas.

Development of a Basin-Wide Water Budget: Development of a basin-wide water budget will provide essential baseline data on water needs and groundwater conditions, serve as a tool for assessing the likely impacts of proposed groundwater management actions, and enable an evaluation of how ongoing changes in land use and water management affect the basin's groundwater resources.

Feasibility Evaluation of Recharge Projects: The basin-wide water balance will illustrate trends in the balance between groundwater recharge and groundwater use. The water balance will probably demonstrate that the basin is full; however, there are recharge options available for sustaining and protecting groundwater supplies. Such projects could include expanded use of South San Joaquin Water Supply Project water and alternative uses of Central Valley Project (CVP) supply by the City. In addition, this management action would continue to support the development and expansion of conjunctive use projects in urban areas with poor groundwater quality (i.e., supplement urban areas around the City with surface water in order to reduce its reliance on groundwater and prevent further migration of poor quality water).

Hydrologic Investigation: A hydrogeologic assessment was completed as part of the preparation of this GMP based on readily available data. Because most of the data available was from existing groundwater wells, there was limited information available from those areas with few or no wells. An expanded hydrogeologic investigation should be completed to supplement the existing information and fill data gaps. Specifically, the investigation would provide additional hydrogeologic information in key areas such as the potential recharge areas in the southwest part of the basin and provide dedicated multi-completion monitoring wells to the expand the monitoring program. Additional information developed as part of this project would also support the evaluation of recharge projects.

Support of Public Health Programs: Well construction and demolition standards are designed specifically to protect groundwater quality. Management actions to assist local agencies in complying with public health standards include the following components:

- Installation of sanitary well seals on all new wells in accordance with the California Well Standards.
- Installation of wells that conform to San Joaquin County standards that include an impermeable seal between the upper and lower aquifers to prevent low quality water in the upper aquifer from entering the lower aquifer.
- Abandonment and destruction of wells in accordance with the California Well Standards.

Water Quality Management: The protection of groundwater quality is a concern because the basin's population is growing and there is increased competition for potable water. A detailed geologic assessment of the basin focusing on the areas with poor water quality and identifying the sources of the poor quality should be conducted. This assessment would result in mapping recharge areas and development of strategies to control the migration and movement of poor quality water into and throughout the basin.

Groundwater Monitoring and Subsidence Monitoring Program: Groundwater monitoring and analysis and archiving of collected data are needed to implement several of the recommended management actions (e.g., conjunctive management and water quality management). Additional monitoring is needed to fill data gaps identified in the monitoring plan and provide dedicated monitoring locations. It is also recommended that the GAC consider developing a database to facilitate the storage, retrieval, and archiving of groundwater data.

Policy Assessment: Several of the technical management actions introduced above have clear policy requirements and implications. For example, effective protection of natural recharge areas will require coordination and communication with entities responsible for land use policies. Similarly, annexations to expand agencies' service areas as part of an in-lieu recharge

program presume clear policies regarding annexation and a process to evaluate the impacts of annexation on groundwater levels and groundwater quality.

Promoting Cooperation and Coordination between Water Entities: The GAC will continue to coordinate water management activities within the basin and to work cooperatively for implementation of agreed-upon BMOs. The GAC should also develop an outreach and educational program to engage other water interests for management of the basin. One example of such outreach would be working cooperatively with industrial water users to improve water quality in the basin.

1 Introduction

1.1 Introduction

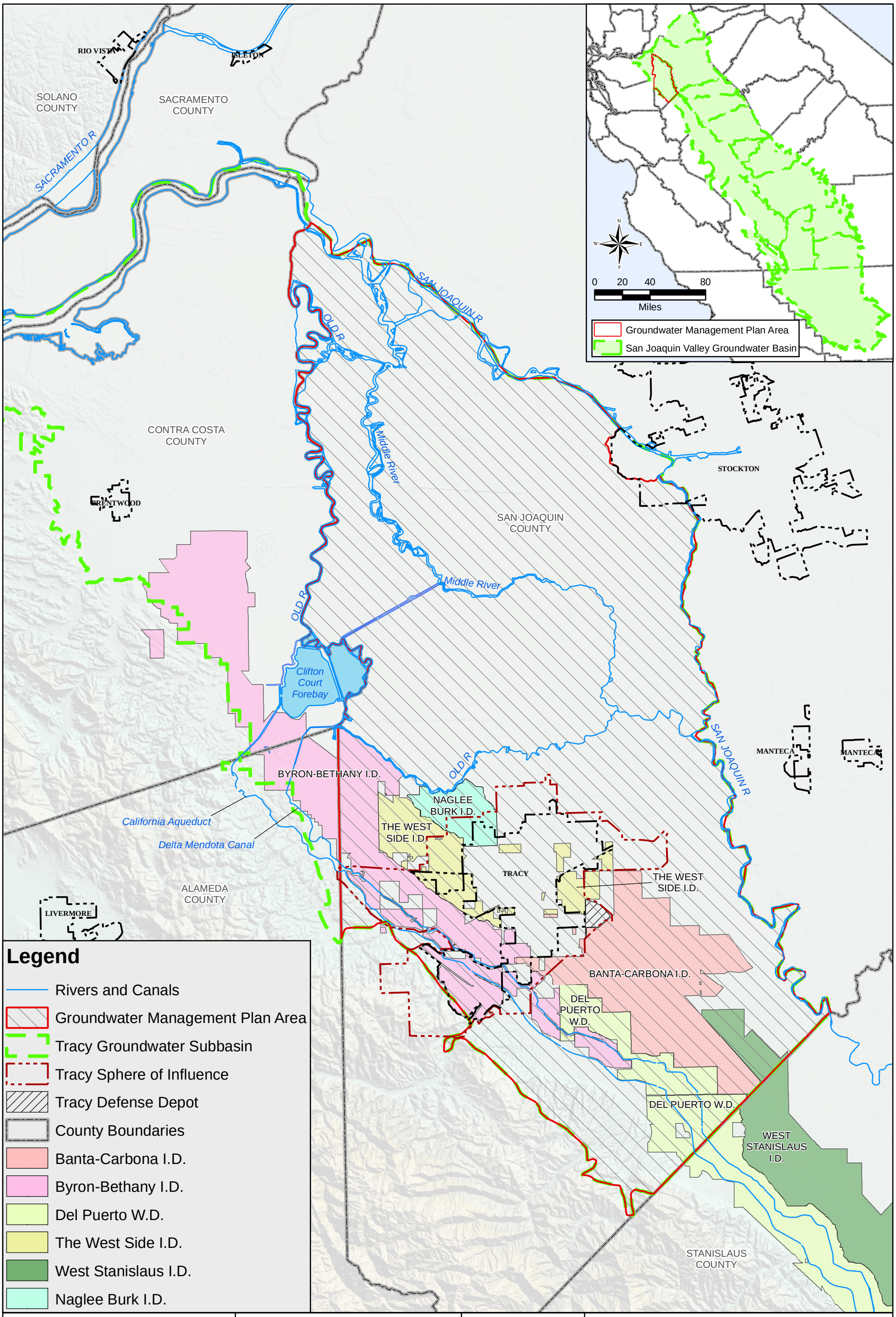
The City of Tracy is leading the effort to develop a regional Groundwater Management Plan (GMP) for the San Joaquin County portion of the Tracy Subbasin. The City wants to better manage the available groundwater resources to meet current and future water needs by proactively addressing challenges and maximizing opportunities in the subbasin. The Tracy Subbasin (Figure 1.1) is part of the larger San Joaquin Valley Groundwater Basin (Basin), which extends from Kern County to San Joaquin County. The Tracy Subbasin includes portions of San Joaquin County, Alameda County, and Contra Costa County. The population of the City and San Joaquin County are expected to continue to grow in the future. This growth will require careful planning to ensure that surface water and groundwater resources in the area are improved and protected.

Water needs throughout the Tracy Subbasin are relatively stable. It is projected that land use will change over time as agricultural lands are urbanized, but the overall water demand is not expected to change substantially. The competition for high-quality, municipal-grade groundwater within the Tracy Subbasin, however, is expected to increase with continued urbanization. In addition, the City and other water management agencies face additional institutional, regulatory, and environmental challenges in managing groundwater resources in the subbasin.

Local water interests within the Tracy Subbasin are working together to meet water supply challenges and to take advantage of opportunities that occur within the Tracy Subbasin. These local water interests formed the GAC to foster cooperation and coordination within the Tracy Subbasin. The City took the leadership role to form the GAC.

Regional cooperation by local water interests is needed to wield influence at the state and federal levels; to compete for funding with large, regional organizations and well-funded coalitions; and to overcome technical and organizational challenges. The development of a GMP is an important step in defining a clear strategy to fully utilize and locally manage the water resources of the Tracy Subbasin and develop cost-effective long-term water supplies.

Properly managed, the Tracy Subbasin can provide for the water needs of the area for many years and create opportunities for conjunctive management with surface water supplies. However, high-quality groundwater is replenished at rates lower than extraction rates, which results in declining groundwater quality. This creates a potential for future conflicts over the available high-quality groundwater supply.



Tracy Regional Groundwater Management Plan

San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

Tracy Groundwater Subbasin

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FIGURE 1.1

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1.2 Regional Groundwater Management Plan Area

For many years, water users have been independently managing surface water and groundwater resources in the Tracy Subbasin; however, this is the first regional water management planning effort for the area. The regional groundwater plan area encompasses the portion of the Tracy Subbasin within San Joaquin County (Figure 1.1). Most of the groundwater pumping occurs in the area south of Old River. North of the river surface water from the Sacramento-San Joaquin Delta is used to meet most of the water demand.

As shown in Figure 1.1, the plan area overlies the Tracy Subbasin, as defined in the California Department of Water Resources (DWR) Bulletin 118 (DWR 2003). In 1996, agencies of the San Luis and Delta-Mendota Water Authority (SLDMWA) and the San Joaquin County Flood Control and Water Conservation District (SJCFCWCD) developed and adopted a GMP to meet the requirements of the Groundwater Management Act of 1992. The plan area for that document consisted of the coterminous boundary of the SLDMWA water agencies and the San Joaquin and Old Rivers. The GMP included portions of the Tracy Subbasin and Delta-Mendota Subbasin, however, neither in its entirety. The Assembly Bill (AB) 3030 plan may not satisfy the requirements of recent groundwater management legislation (SB 1938). The GMP included specific recommendations for implementation, which have not been consistently implemented.

1.3 Existing Groundwater Management Activities

Existing groundwater management activities included groundwater level and quality monitoring programs, wellhead protection, well construction and destruction programs, planned groundwater pumping by the City, and remediation activities at the Tracy Army Depot. The monitoring programs are conducted by the SJCFCWCD, DWR, and the City. For the planned groundwater pumping by the City, the City determined the operational yield of the groundwater system as defined by its City boundary. The City operates its groundwater pumping in accordance with the previously defined operational yield. The U.S. Army Corps of Engineers (USACE) maintains a groundwater remediation program at the Tracy Army Depot and pumps and remediates approximately 600 acre-feet of groundwater per year.

The San Joaquin County EHD manages programs associated with water supply well construction, well destruction, and wellhead protection. The purpose of these programs is to prevent groundwater contamination and safety hazards by regulating the location, construction, repair, and destruction of water supply, monitoring, and geophysical wells and borings.

1.4 Report Outline

The following provides a description of each section and appendix included in this GMP.

Section 1 Introduction: Background information and context for the GMP.

Section 2 Need for Groundwater Management Planning: Provides information regarding the legislative background for groundwater planning.

Section 3 Water Resources Settings: Defines the water supply and management problems to be addressed in the GMP and describes the baseline conditions and lays the foundation for establishing GMP goals and objectives. It also provides an overview of the physical setting, including the climate, soils, and geology and describes any major planning constraints. Also presented are current and future land use, water demands, water sources, existing water supply facilities, groundwater conditions, and water quality for the Tracy Subbasin.

Section 4 Goals and Objectives: Discusses GMP goals and objectives and the specific BMOs that were developed to help quantify the groundwater management goals and objectives. BMOs are set for the subbasin and geographic areas related to stabilizing groundwater quality and for project development.

Section 5 Groundwater Management Measurements: Provides a description of each surface water and groundwater management option that was considered. Other management options or program elements considered for inclusion in the Tracy Subbasin are also discussed, including the required or recommended elements pursuant to SB 1938. The BMOs also set up the planning framework and priorities for interpreting the near-term or long-term applicability of the option. The issues and constraints associated with each individual option were evaluated to determine the applicability and relation to the Tracy Subbasin GMP. Some options were rejected while others were carried forward to be integrated into the GMP components.

Section 6 Stakeholder Involvement: Provides the framework for public involvement in the preparation and implementation of the GMP, for involvement and coordination with other water agencies, for developing relationships with state and federal agencies, and for developing a dispute resolution process.

Section 7 Plan Implementation: Provides information regarding the plan components and how the plan will be managed and implemented.

Section 8 References

Appendix A Tracy Subbasin Regional GMP Preparation Resolutions

Appendix B Tracy Subbasin Regional GMP Adoption Resolutions

Appendix C Meeting Announcements

Appendix D Hydrogeologic Assessment Report

Appendix E Groundwater Monitoring Plan

Appendix F Stakeholder Involvement Documentation

2 Need for Groundwater Management Planning

2.1 Legislative Requirements

Groundwater management is planned and coordinated locally to ensure a sustainable groundwater basin to meet future water supply needs. With the passage of AB 3030 in 1992, local water agencies were provided a systematic way of formulating GMPs (California Water Code, Sections 10750 et seq.). AB 3030 also encourages coordination between local entities through joint power authorities or memorandums of understanding (MOU).

AB 3030 was amended in 2002 with the passage of The Groundwater Management and Planning Act of 2002 (SB 1938). The act amends existing law related to groundwater management by local agencies. The law requires any public agency seeking State funds administered through DWR for the construction of groundwater projects or groundwater quality projects to prepare and implement a GMP with certain specified components. Prior to this, there were no required plan components. New requirements include establishing BMOs, preparing a plan to involve other local agencies in a cooperative planning effort, and adopting monitoring protocols that promote efficient and effective groundwater management.

2.2 GMP Components

The Tracy Regional GMP includes three types of components: SB 1938 mandatory components, AB 303 and SB 1938 voluntary components, and DWR Bulletin 118-suggested components. The seven mandatory components that are required to be compliant with SB 1938 are addressed in the GMP. The GMP also addresses the 12 specific technical elements identified in the California Water Code, along with the seven recommended components identified in DWR Bulletin 118 (DWR 2003). Table 2.1 lists the required and recommended components and identifies the specific location within this GMP where the information can be found.

Table 2.1. Tracy Subbasin Regional GMP Components

Description	Section
SB 1938 Mandatory Components	
1. Documentation of public involvement statement	Appendix C
2. Basin Management Objectives (BMOs)	Section 4
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality or are caused by pumping	Section 3 and Appendix D
4. Plan to involve other agencies located in the groundwater basin	Section 6

Description	Section
5. Adoption of monitoring protocols	Appendix E
6. Map of groundwater basin boundary, as delineated by DWR Bulletin 118, with agency boundaries that are subject to GMP	Section 3
7. For agencies not overlying groundwater basins, prepare the GMP using appropriate geologic and hydrogeologic principles	Not Applicable
AB 3030 and SB 1938 Voluntary Components	
1. Control of saline water intrusion	Section 5
2. Identify and manage well protection and recharge areas	Section 5
3. Regulate the migration of contaminated groundwater	Section 5
4. Administer well abandonment and destruction program	Section 5
5. Control and mitigate groundwater overdraft	Section 5
6. Replenish groundwater	Section 5
7. Monitor groundwater levels	Section 4 and Appendix E
8. Develop and operate conjunctive use projects	Section 7
9. Identify well-construction policies	Section 5
10. Develop and operate groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	Section 5
11. Develop relationships with state and federal regulatory agencies	Section 6
12. Review land use plans and coordinate with land use planning agencies to assess activities that create reasonable risk of groundwater contamination	Section 3
DWR Bulletin 118 Suggested Components	
1. Manage with guidance of advisory committee	Section 6
2. Describe area to be managed under GMP	Section 1
3. Create links between BMOs and goals and actions of GMP	Section 4
4. Describe GMP monitoring programs	Section 4 and Appendix E
5. Describe integrated water management planning efforts	Section 7
6. Report of implementation of GMP	Section 7
7. Evaluate GMP periodically	Section 7

2.3 Purpose and Goals of the Groundwater Management Plan

This document presents the locally developed GMP that reflects current state law; coordinates existing groundwater management; and defines actions for developing project and management programs to monitor the operation of the groundwater basin to ensure the long-term sustainability of groundwater resources in the Tracy Subbasin. This GMP provides action items that, when implemented, will maintain or enhance groundwater levels and water quality, minimize inelastic land subsidence, and manage available surface and

groundwater conjunctively to allow greater operational flexibility. Key results of the planning process documented in this GMP include:

Developing general consensus among Tracy Subbasin stakeholders regarding the characterization of the area's water problems, current and future demands, and groundwater conditions.

Documenting the area's groundwater management goals and objectives, including specific BMOs, to help measure progress in attaining goals.

Developing specific solutions and common programs for the Tracy Subbasin.

Developing management plan components to maintain groundwater quality and prevent land subsidence in the basin.

Providing an implementation plan to direct future groundwater management activities.

2.4 Authority to Prepare Regional Groundwater Management Plan

The City and San Joaquin County Flood Control and Water Conservation District have the authority to manage the groundwater resources in the Tracy Subbasin through California Water Code, Division 6, Part 2.75 (Sections 10750 et seq.). However, the City is the primary agency responsible for this GMP, and it actively manages the groundwater basin within its political boundary. The City has prepared this GMP and has invited San Joaquin County Flood Control and Water Conservation District and other water agencies to participate in its development. This GMP is consistent with the provisions of California Water Code, Sections 10750 et seq., as amended January 1, 2003.

3 Water Resources Setting

This section summarizes the water resources conditions present in the GMP area. It describes the historical and baseline conditions of the water resources in the Tracy Subbasin and contains an overview of the physical setting, including the climate, soils, and geology and describes the major planning considerations related to those issues. This includes a discussion of the current and future land use and associated water demands, water supplies and sources, existing water supply facilities, groundwater levels, and water quality conditions.

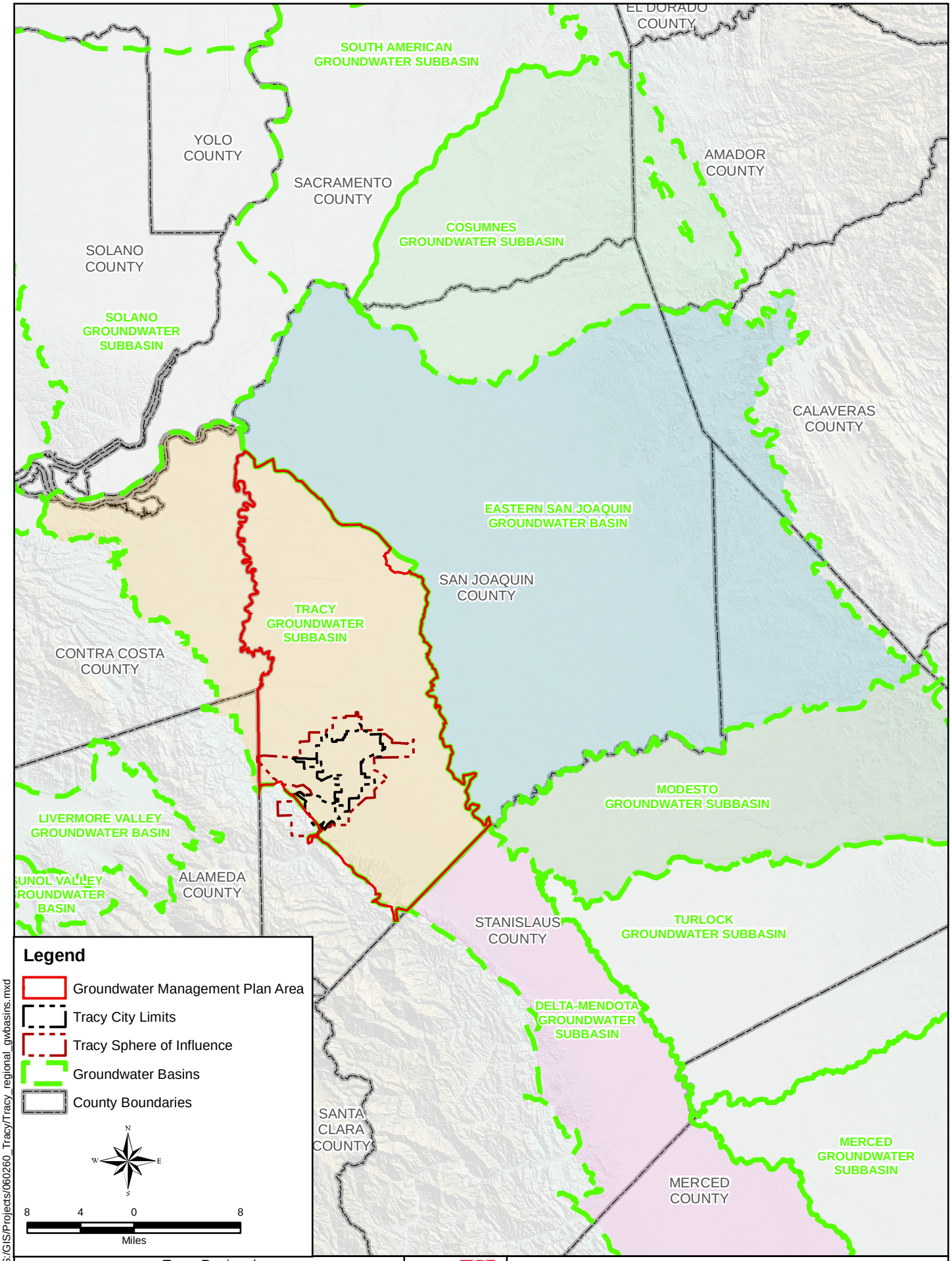
3.1 Scope and Approach

Previous reports were reviewed and the available data were analyzed to document the historical and existing conditions of the groundwater basin and to identify unique characteristics of the GMP area. Groundwater data were analyzed to evaluate trends, document changes in storage, assess groundwater occurrence, flow, and quality. Groundwater hydrographs were prepared at different locations throughout the GMP area. The results of the analyses were used by the GAC to establish GMP goals and objectives. The data and results of the analyses are summarized in this section. More detailed data and results are provided in the appendices.

3.2 Physical Setting

3.2.1 Groundwater Basin

The Tracy Subbasin underlies an area of approximately 539 square miles and is part of the San Joaquin Valley Groundwater Basin, which is a structural trough about 200 miles long and 70 miles wide. Figure 3.1 presents a map showing the plan area of the Tracy Subbasin and surrounding groundwater basins as defined by DWR. It is bounded on the north and the east by the San Joaquin River, on the south by the San Joaquin-Stanislaus Counties, and on the west by the aeral extent of sedimentary deposits bounded by the Diablo Range. There are no geologic features or faults that would prevent water from flowing into or out of the Tracy Subbasin. The San Joaquin River, Old River, and Middle River are the principal rivers within or bordering the subbasin. Additional channels of the Sacramento-San Joaquin River Delta (Delta) are present north of Old River.



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Tracy Regional
Groundwater Management Plan

San Joaquin County, California

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GROUNDWATER BASINS

JANUARY 2007

FIGURE 3.1

Groundwater storage capacity in the Tracy Subbasin has not been estimated. However, it has been inferred that the storage capacity of the area between one mile north of Tracy and the southern boundary of the Tracy Subbasin is 1.3 million acre-feet (DWR, 2003). Beneath the City there are over 3,000 feet of non-marine sediments (State Division of Mines, 1943), but only the upper 800 to 2,000 feet of these sediments contain water that is considered potable or suitable for drinking or agricultural use.

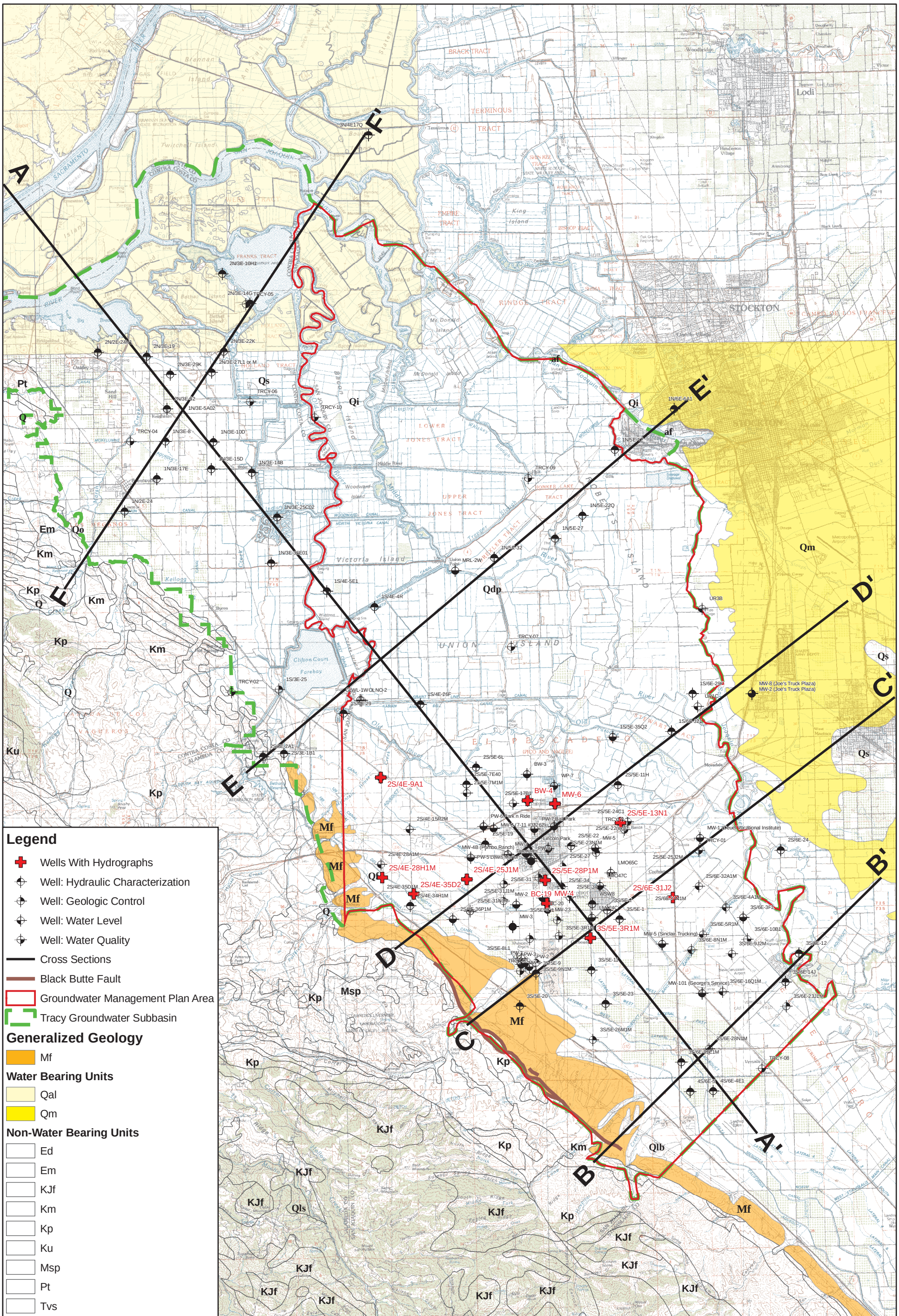
3.2.2 Basin Topography

There is little change in ground surface elevation in the Tracy Subbasin. Ground surface elevations are the highest, approximately 200 feet above mean sea level, on the southwestern side of the Tracy Subbasin and gradually decline to the north and east. The lowest portions of the Tracy Subbasin are on the islands located in the Delta, which are below sea level.

3.2.3 Geology

The Tracy Subbasin is comprised of continental deposits of Late Tertiary to Quaternary age. These deposits include the Tulare Formation, Older Alluvium, Flood Basin Deposits, and Younger Alluvium. The cumulative thickness of these deposits increases from a few hundred feet near the Coast Range foothills on the west to about 3,000 feet along the eastern margin of the Basin. Information regarding the water-bearing units and groundwater conditions were taken from several sources (Hotchkiss and Balding 1971, Bertoldi et al. 1991, Davis G.H. et al. 1964). Figure 3.2 shows the surface geology of the Tracy Subbasin and indicates the location of a geologic cross section presented in Figure 3.3. The cross section shows the relationship between geologic units below the surface in the Tracy Subbasin. The figure is illustrative of the principal clay layer present in the subbasin. The presence of a clay layer influences conjunctive use and is a factor in managing the groundwater system.

Impermeable/semi-impervious clay layers extend throughout the Tracy Subbasin, as shown in Figure 3.4. Impermeable clay layers are present in the western portion of the basin and their presence is uncertain in the eastern portion of the basin. The principal clay layer is the E-clay, also called the Corcoran clay, which is present throughout much of the Tracy Subbasin. This clay layer is associated with flood and marsh deposits of the San Joaquin Valley lowlands. The clay layers interfinger with alluvial deposits of the valley. The aquifers beneath the clay layers are confined and under pressure (they are discussed later in the text). The presence of the confining clay layers also means that sands and gravels that make up the aquifer are not in direct connection with the land surface or potential sources of recharge. As a result, recharge to replace water removed by wells must enter the aquifer from sources up gradient of the pumping wells where the clays become discontinuous. This is the area in the western edge of the Tracy Subbasin. The Corcoran clay separates the unconfined aquifer from the confined aquifer.


A
A'
B
B'
C
C'
D
D'
E
E'
F
F'
Legend
Wells With Hydrographs
Well: Hydraulic Characterization
Well: Geologic Control
Well: Water Level
Well: Water Quality
Cross Sections
Black Butte Fault
Groundwater Management Plan Area
Tracy Groundwater Subbasin
Generalized Geology
Mf
Water Bearing Units
Qal
Qm
Non-Water Bearing Units
Ed
Em
KJf
Km
Kp
Ku
Msp
Pt
Tvs
2S/4E-9A1
BW-4
MW-6
2S/5E-13N1
2S/4E-28H1M
2S/4E-25J1M
2S/5E-28P1M
2S/4E-35D2
2S/6E-31J2
BC-19
MW-4
3S/5E-3R1M
Lodi
STOCKTON
Miles
2 1 0 2
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E
Tracy Regional
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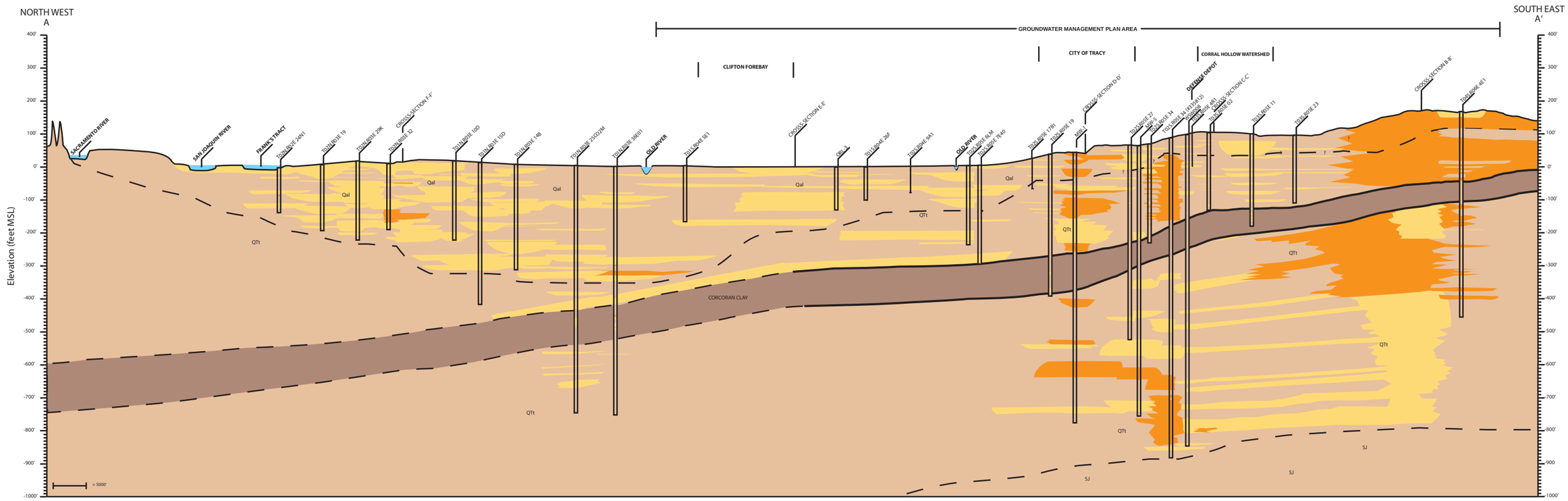
WELL LOCATIONS AND
GENERALIZED GEOLOGY IN
TRACY GROUNDWATER SUBBASIN
JANUARY 2007
FIGURE 3.2
16-Jan-07 S:/GIS/Projects/060260/Tracy_basemap_fig1_wells.mxd



LEGEND

Qal: Alluvium
QTt: Tulare Fm
Mf: Fanglomerate
Kp: Panoche Fm
SJ: San Joaquin Clays

GRAVELS
SANDS
SILT/CLAY
CORCORAN CLAY

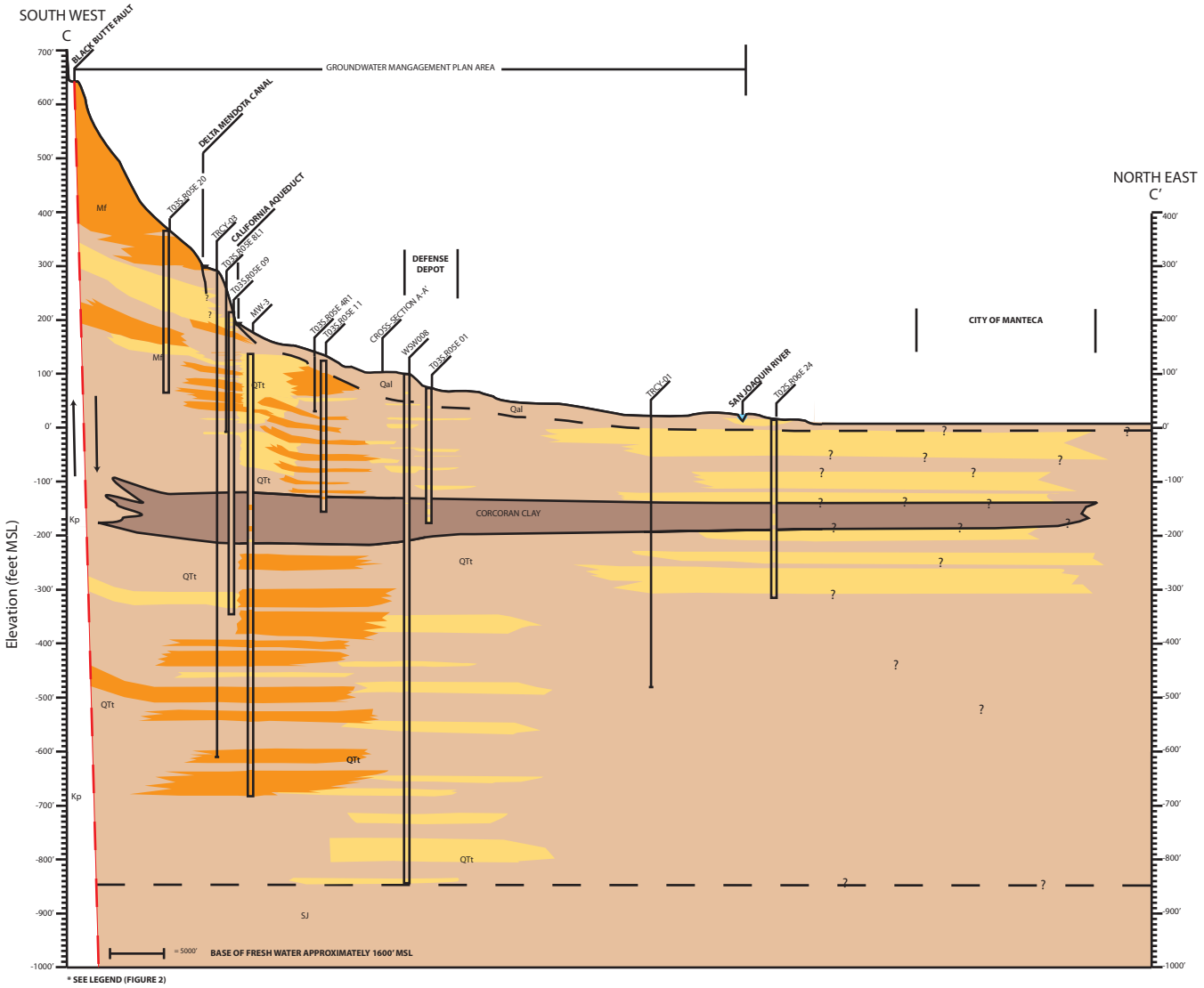
Fault, arrows showing direction of movement

Geologic contact. Dashed where inferred, question mark where unkown

= Wells used for geology, hydrogeology interpretation and water quality and levels where available.

= Wells used for water quality and water level data.

Tracy Regional Groundwater Management Plan	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION A-A'
San Joaquin County, California		JANUARY 2007 FIGURE 3.3



Tracy Regional Groundwater Management Plan	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION C-C'
San Joaquin County, California		JANUARY 2007 FIGURE 3.4

Typically, wells in a confined aquifer are less susceptible to contaminants that originate at the land surface directly above the area of influence for a well than are wells screened in semiconfined or unconfined aquifers. In the Tracy Subbasin, the implication is that cities relying on groundwater that are located above clay layers should construct wells in and below the clay layers to lessen the likelihood of contamination. All wells should be constructed with adequate seals between the formations to prevent the downward migration of poor quality water. Site-specific surface, near surface, and subsurface geologic conditions will be evaluated more extensively as part of engineering feasibility studies conducted for specific recharge projects.

3.2.4 Formations

3.2.4.1 Tulare Formation

The Tulare Formation is exposed in the Coast Range foothills along the western margin of the subbasin. The formation dips eastward toward the axis of the valley and consists of semi-consolidated, poorly sorted, discontinuous deposits of clay, silt, and gravel. The Corcoran clay occurs near the top of the Tulare Formation and provides confinement. The Tulare Formation is moderately permeable, and most of the larger agricultural, municipal, and industrial operations extract from this formation. Wells completed in this zone can produce up to 3,000 gallons per minute (gpm). The thickness of the Tulare Formation is about 1,400 feet. Specific yield values for water-bearing deposits in the San Joaquin Valley and Delta area range from about 7 to 10 percent.

3.2.4.2 Older Alluvium

Older alluvium consists of loosely to moderately compacted sand, silt, and gravel deposited in alluvial fans during the Pliocene and Pleistocene ages. The older alluvium is widely exposed between the Coast Range foothills and the Delta. The thickness of the older alluvium is about 150 feet.

3.2.4.3 Flood Basin Deposits

Flood basin deposits are present in the Delta portion of the subbasin. They consist of silts and clays. The flood basin deposits have low permeability and generally yield low quantities of water to wells due to their fine-grained nature. Flood basin deposits generally contain poor quality groundwater with occasional zones of fresh water. The maximum thickness of the unit is about 1,400 feet.

3.2.4.4 Younger Alluvium

Younger alluvium includes those deposits that are accumulating or would be accumulating under natural conditions. It includes sediments deposited in the channels of active streams as well as overbank deposits and terraces of those streams. They are present along Corral Hollow Creek and consist of unconsolidated silt, sand, and gravel. Sand and gravel zones in

the younger alluvium are highly permeable and yield significant quantities of water to wells. The thickness of the younger alluvium in the Tracy Subbasin is less than 100 feet.

3.2.5 Base of Fresh Water

The Tracy Subbasin is underlain by saline water. The base of fresh water is the boundary between water of total dissolved solids (TDS) of about 2,000 milligrams per liter (mg/L). In the Tracy Subbasin, the mapped base of fresh water ranges from about 800 to 2,000 feet (Page, 1973 and Berkstresser, 1973).

3.2.6 Aquifer Definition

The Tracy Subbasin is primarily separated into two aquifers – unconfined and confined. The unconfined aquifer is primarily comprised of the alluvium and flood basin formations. The confined aquifer is primarily comprised of the Tulare Formation and it is overlain by the Corcoran clay.

3.2.7 Hydraulic Characteristics

The hydraulic characteristics of sediments and aquifers provide the foundation for predicting the potential effects of groundwater management options. They are used to estimate speed and direction of groundwater movement, groundwater storage, and the potential effects of groundwater pumping on groundwater levels. Several hydraulic characteristic terms are used. *Hydraulic conductivity* is the ability of the sediments to transmit water in sediments. *Transmissivity* is the hydraulic conductivity multiplied by the thickness of the sediments capable of storing water. All sediments have some void space between the particles; this void space is reported as *porosity*. Water in the void spaces cannot be entirely removed. The *storage coefficient* is the percentage of water that can be removed from the pores by gravity drainage and is applied when describing unconfined aquifers. *Storativity* is similar to storage coefficient, but is the percentage of water that can be released from the pores by a decrease in pressure. Storativity is used when referring to semi-confined or confined aquifers.

The hydraulic characteristics of the unconfined aquifer are highly variable. Wells in the unconfined aquifer produce 6 to 5,300 gpm; however, pumping test data are limited. The transmissivity of the unconfined aquifers, including the recent alluvium and upper portions of the Tulare Formation, ranges between 600 to greater than 2,300 gallons per day per foot (gpd/ft). The storativity is about 0.05. Where thicker sequences of sand are present, the transmissivity may be higher.

Wells in the confined aquifer produce about 700 to 2,500 gpm. The transmissivity ranges from about 12,000 to 37,000 gpd/ft and could go as high as 120,000 gpd/ft. The storage coefficient or storativity, obtained through aquifer tests, was measured as 0.0001 (Padre, 2004).

The Corcoran clay is a regional layer that restricts movement between the unconfined and confined aquifers. Because the clay is permeable to some degree, water can migrate vertically through the layer but typically at very slow rates. Although this migration rate is very slow, the amount of water moving through the clay can be significant given the large area covered by the clay and head differences across the clay. No test data are available for the Corcoran clay, but estimates of the vertical permeability ranged from 0.01 to 0.007 feet per day (Burow et al., 2004).

3.2.8 Groundwater Levels

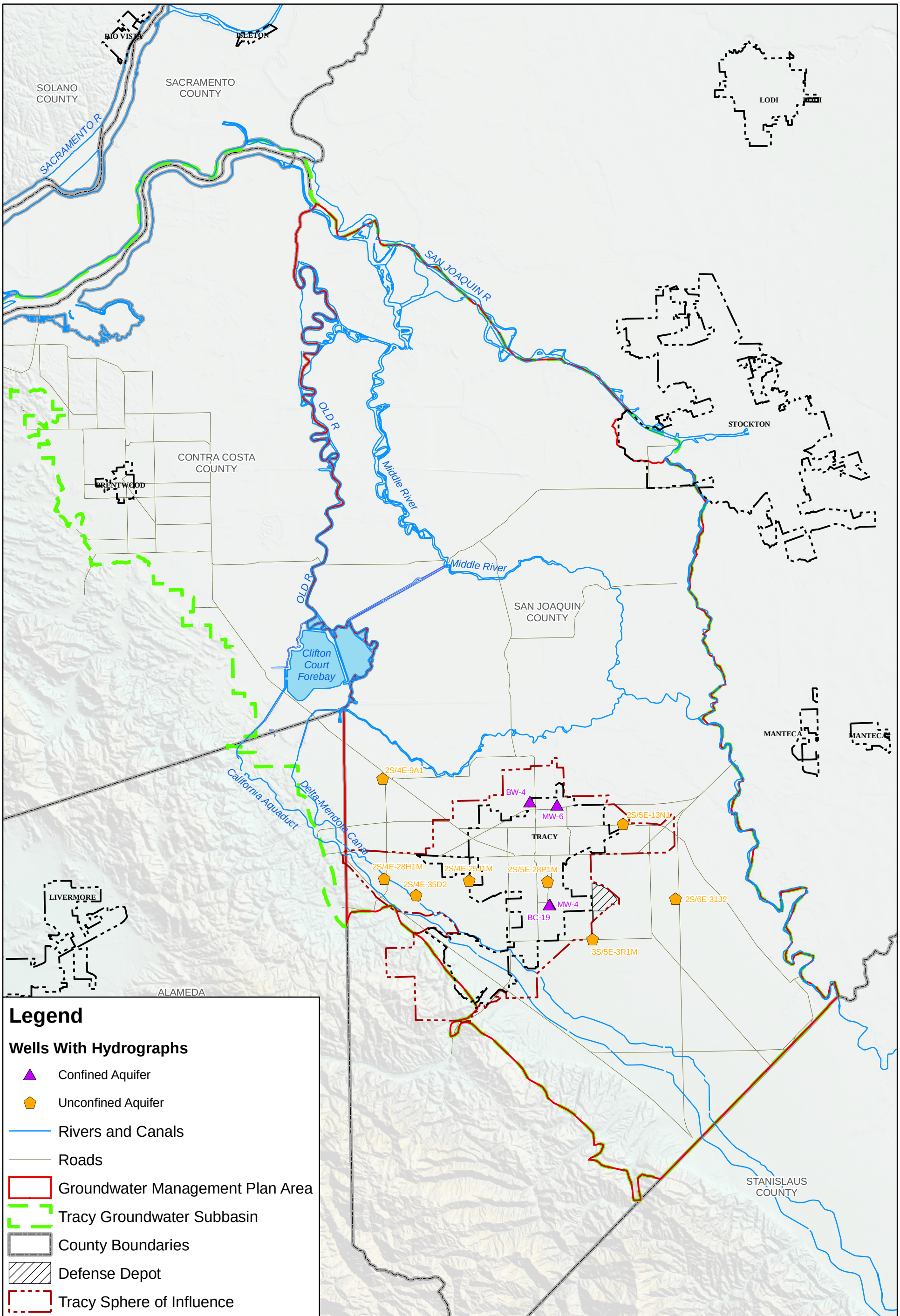
Groundwater levels have been monitored in the southern portion of the subbasin by DWR and San Joaquin County for many years. DWR monitored over 100 wells up to the mid 1970s when the level of monitoring decreased. Nineteen of these wells were screened in just one aquifer, all within the unconfined aquifer. Currently, DWR only monitors 17 wells of which only four have drillers' well logs that show what aquifers the wells are perforated in and these wells are screened above and below the Corcoran clay and represent a composite of both aquifers, so they are not useful to describe water levels in either aquifer. The remaining wells do not have any well construction details; therefore, the aquifers being monitored are unknown. The current groundwater level data from DWR monitored wells cannot be used to interpret groundwater levels in the subbasin.

San Joaquin County is monitoring groundwater levels in 15 wells within the study area. Only four of the wells have (1) logs that show the construction details and (2) monitor water levels in the unconfined aquifer. These wells can be used to interpret groundwater levels. The Hydrogeology Report included in Appendix D provides additional information regarding groundwater level data.

3.2.8.1 Unconfined Aquifer

Eight wells were used to evaluate groundwater levels in the unconfined aquifer. The location of these wells is shown in Figure 3.5. Hydrographs from these eight wells are shown in Figure 3.5.

Although there are multiple coarse-grained sediment layers that make up the unconfined aquifer, the water levels are generally similar in the unconfined aquifer. Groundwater levels in the unconfined aquifer show two trends. Wells that are located in the northern portion of the study area, within the Delta area, have groundwater level trends that are generally flat lying, showing the aquifer is full. Based on the aquifer profiles, the groundwater is in hydraulic communication with the San Joaquin and Sacramento Rivers. Groundwater levels are likely to fluctuate partly in response to tidal influences. Wells 2S/4E-28H1 and 2S/4E-35D2, located near the southwestern margin of the basin, show that groundwater levels prior to 1970 were lower and have since recovered by as much as 140 feet.



Tracy Regional
Groundwater Management Plan

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TRACY GROUNDWATER SUBBASIN
GROUNDWATER HYDROGRAPH LOCATIONS

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FIGURE 3.5

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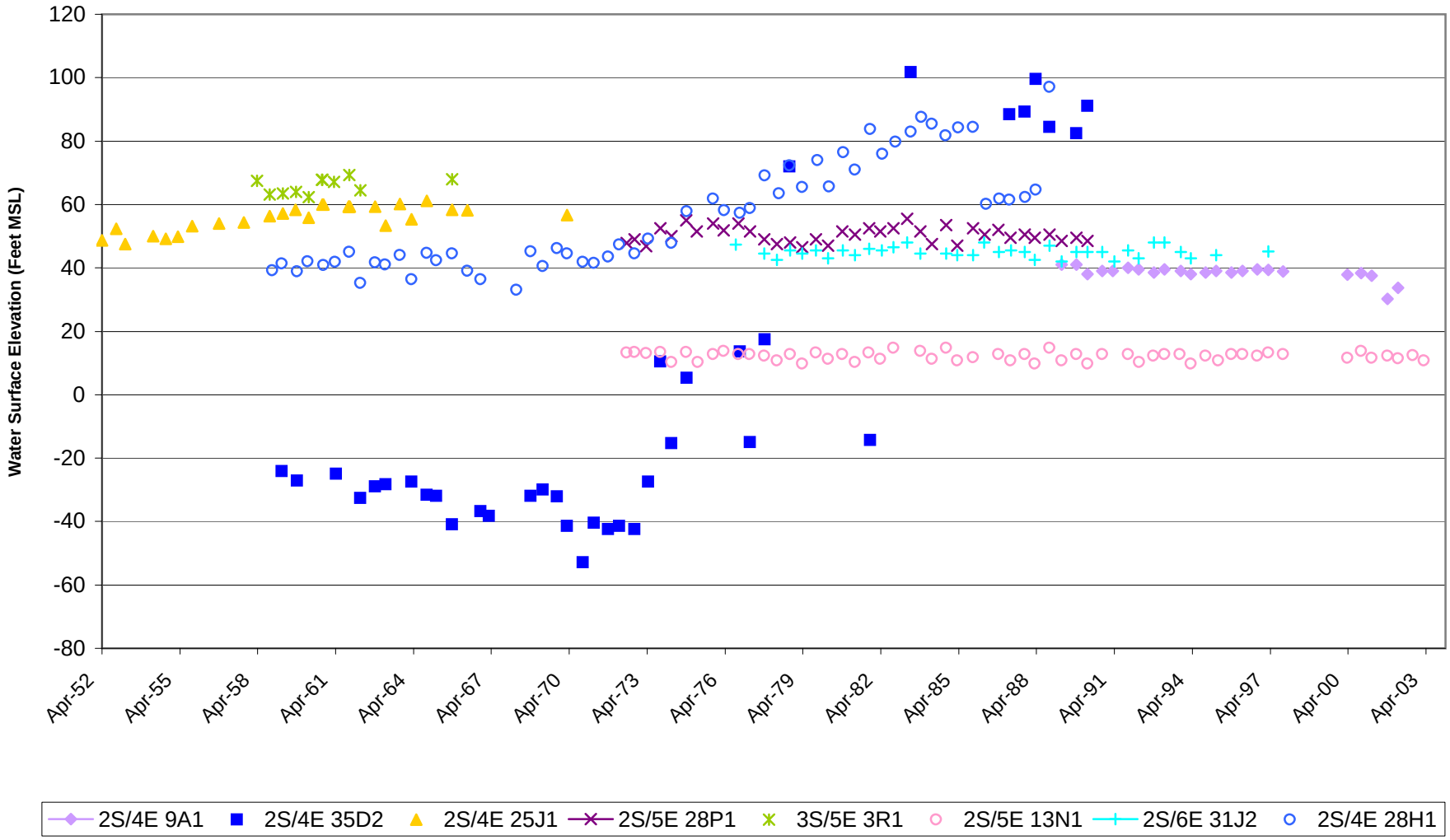
Figure 3.6 Groundwater Level Hydrographs for the Tracy Groundwater Subbasin for the Unconfined Aquifer



3.2.8.2 Confined Aquifer

The City is the principal water agency that actively monitors water levels in the confined aquifer. Groundwater levels (piezometric heads) from four wells are shown in Figures 3.7 and 3.8. Groundwater levels in the confined aquifer are about -65 to 75 feet. The groundwater levels are always above the top of the Corcoran clay by about 200 to 240 feet.

Groundwater levels in the confined aquifer show a mixture of downward gradients and upward gradients that range from one to nine feet between each coarse-grained sedimentary layer. There is a consistent downward gradient between the individual aquifers in the southern and western portions of the city, with an upward gradient between the lower two aquifers in the eastern and northern portions of the city. The downward heads may indicate a potential recharge area.

3.2.9 Groundwater Flow Directions

Groundwater contour maps show the direction of groundwater flow, recharge areas, and areas of discharge. The groundwater flow direction is typically 90 degrees to the groundwater contour.

3.2.9.1 Unconfined Aquifer

The groundwater flow direction in the unconfined aquifer is northerly toward the Old River. Groundwater recharge to the unconfined aquifer is from the Coast Ranges, possibly from Corral Hollow Creek or Hospital Creek. Groundwater may be discharging to the San Joaquin River. Figure 3.9 shows groundwater contours developed for the unconfined aquifer for spring 2005. The groundwater measurements used to generate the contours are not from a single date but were obtained over a four-month period and likely affect the interpretation.

3.2.9.2 Confined Aquifer

Groundwater contours for the confined aquifer are limited to those measurements that have been made near the City. Figure 3.10 shows groundwater contours for October 2005 based on water level measurements from the City's production wells perforated below the E-clay. The contours show groundwater in the confined aquifer is moving in a radial pattern from the south, east, west, and north toward pumping depressions beneath central portions of the City. The gradient is steeper on the north side of the depression, suggesting the presence of lower permeability aquifers or a recharge source. A recharge source is more probable.

Figure 3.7 Groundwater Level Hydrographs for City of Tracy Wells BC-19 and MW-4A

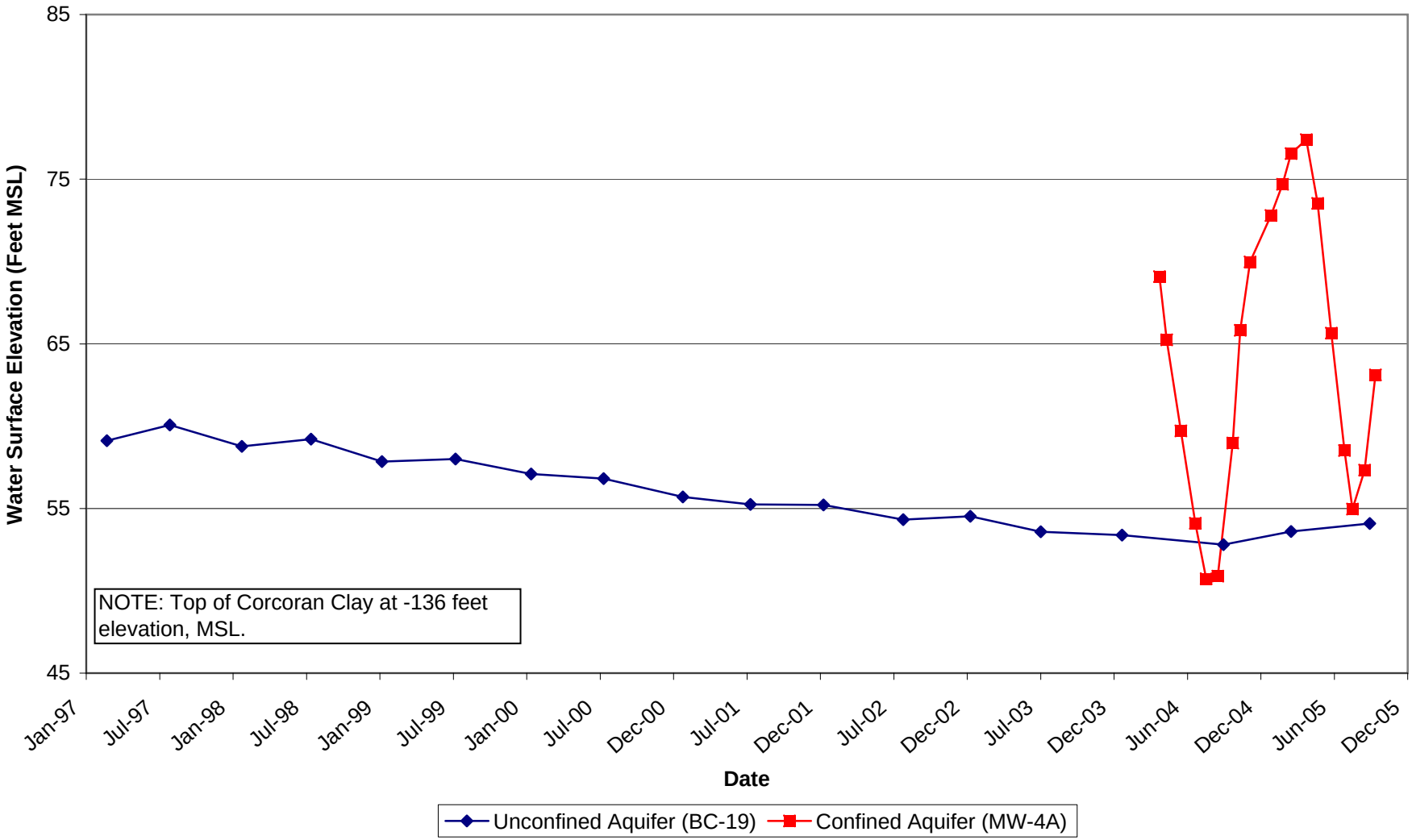
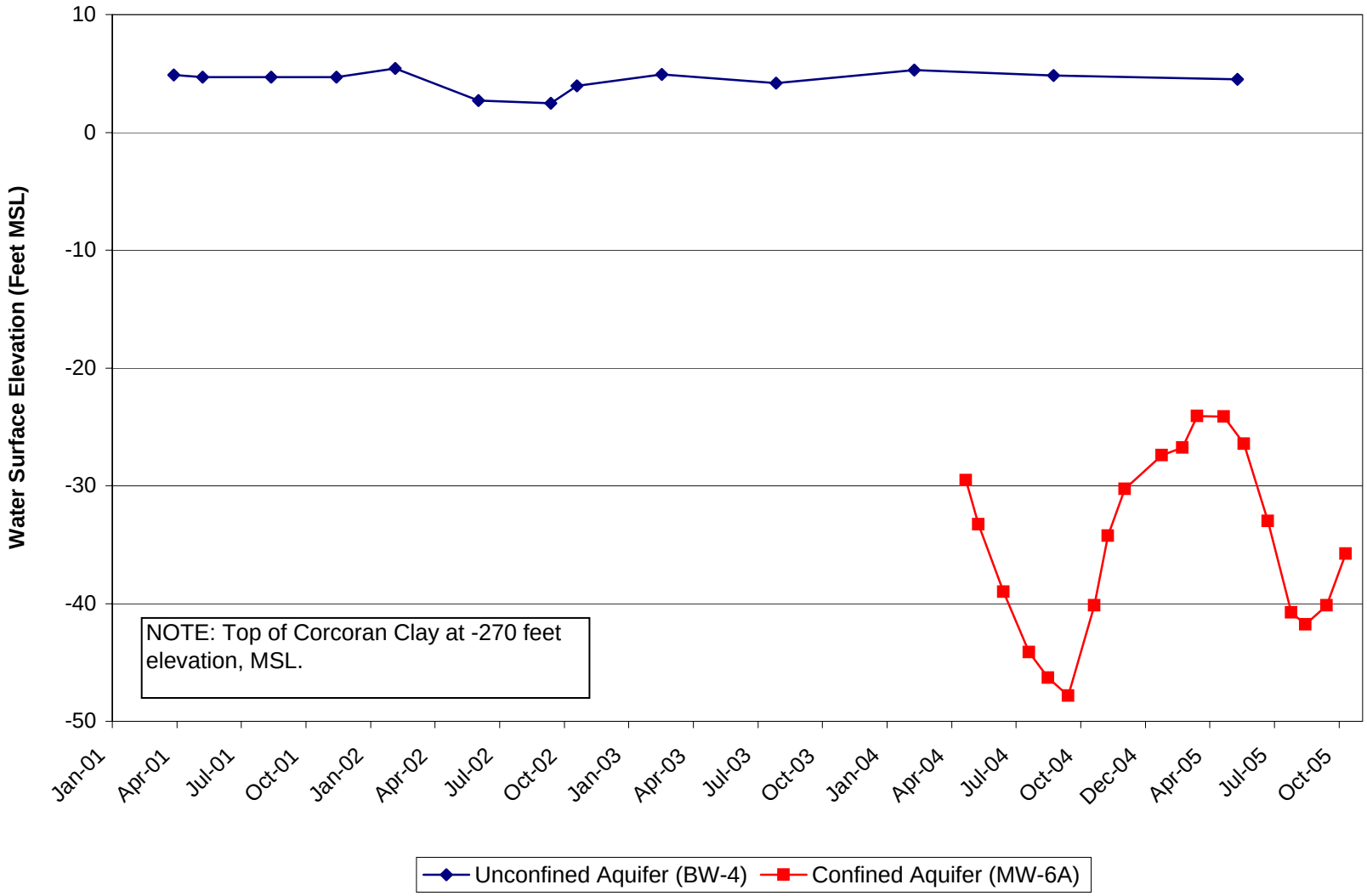
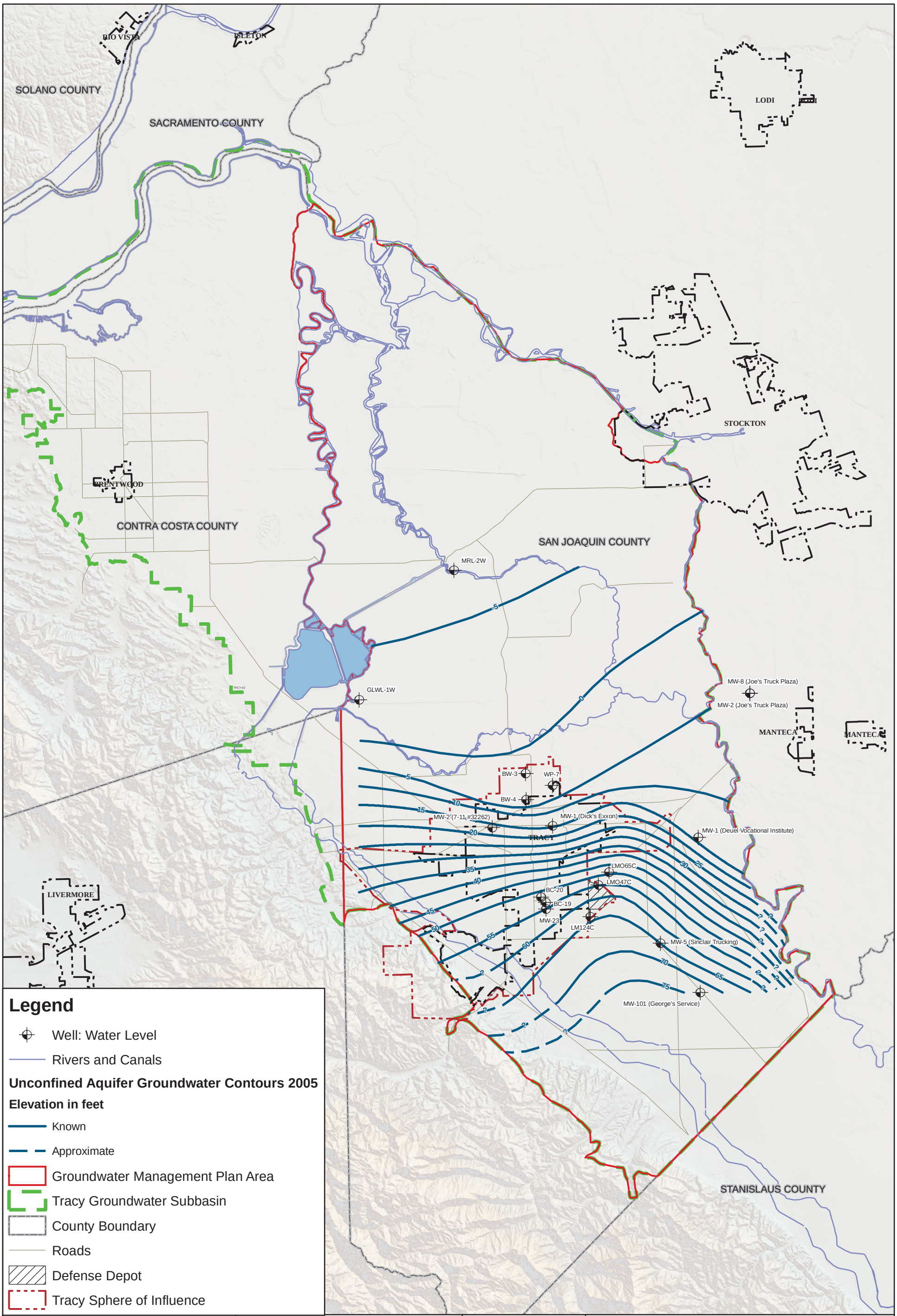


Figure 3.8 Groundwater Level Hydrographs for City of Tracy Wells BW-4 and MW-6A





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CONTOUR MAP OF SPRING 2005 UNCONFINED AQUIFER GROUNDWATER LEVELS

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FIGURE 3.9

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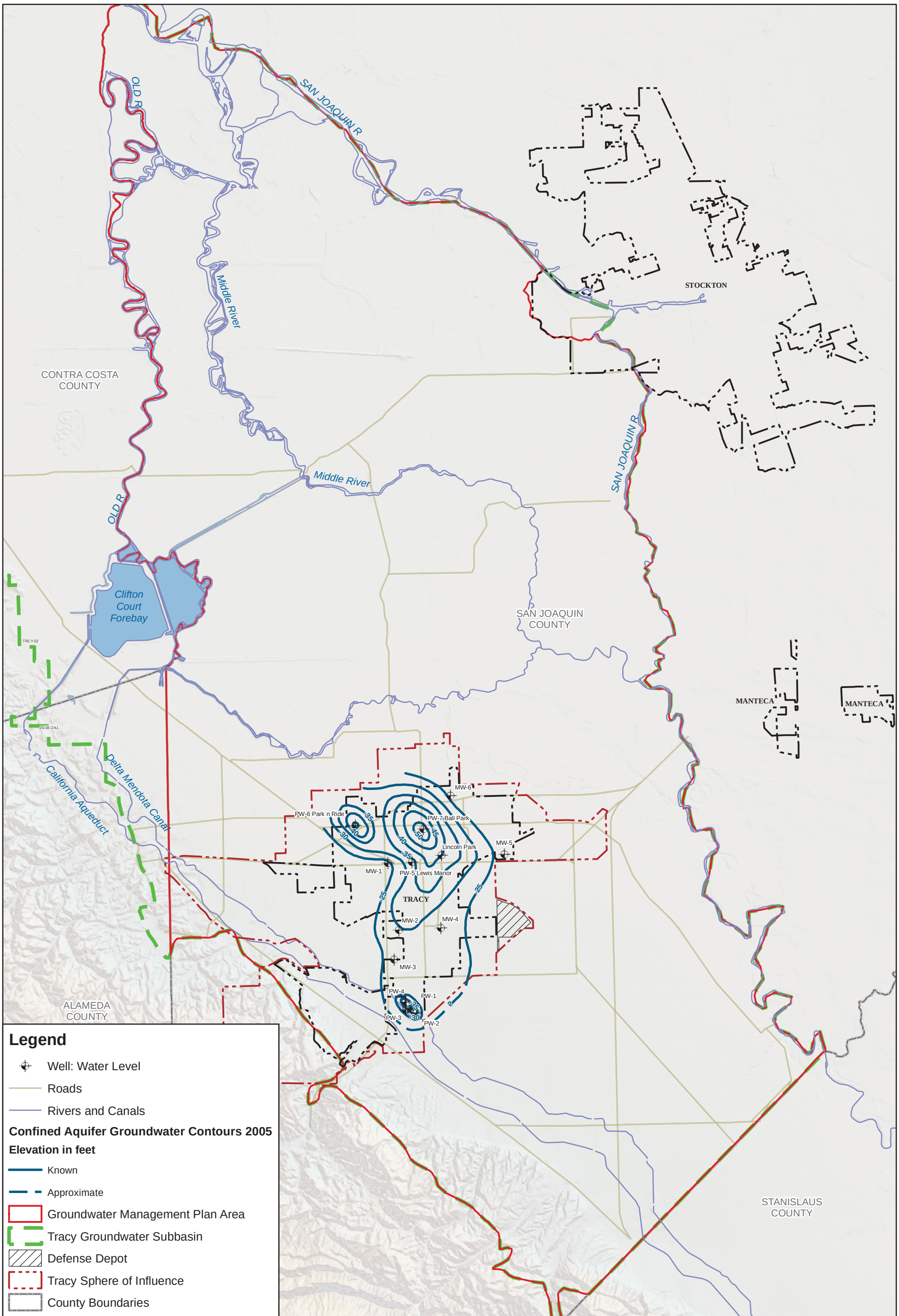

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CONTOUR MAP OF SPRING 2005 CONFINED AQUIFER GROUNDWATER LEVELS

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FIGURE 3.10

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3.2.10 Groundwater Recharge and Discharge Areas

3.2.10.1 Unconfined Aquifer

Groundwater recharge in the unconfined aquifer occurs from rainfall, applied water, and seasonal infiltration by the creeks. The recharge for the shallow unconfined aquifer is generally from the south, from the Coast Ranges, and moves to the north and west. Pumping within the unconfined aquifer can move water from the Delta and the San Joaquin and Sacramento Rivers into the aquifers because they are in direct communication with these surface water bodies.

3.2.10.2 Confined Aquifer

Recharge to the confined aquifer is from the unconfined aquifer where the Corcoran clay is absent adjacent to the Coastal Range foothills. Groundwater recharge to the confined aquifers is also from the east side of the San Joaquin River where the Corcoran clay is absent.

Locally, groundwater may move between the unconfined and confined aquifers through improperly constructed gas wells and water supply wells that have perforations within both the unconfined and confined aquifers. The gravel packs that surround the wells can also convey water vertically. Dependent upon the level of the groundwater surface or the piezometric head, the unconfined aquifer can recharge the confined aquifer or vise versa. In the fan area south of the City, the confined aquifer will recharge the unconfined aquifer where, within and north and east of the City, the unconfined aquifer will recharge the confined aquifer.

3.2.11 Groundwater Quality

Groundwater quality data for the unconfined aquifer is limited to a basin-wide study in 1968 and analysis from available sources, mostly environmental studies. The 1968 water quality information is used to identify constituents of concern, while electrical conductivity and total TDS measurements for 2005 were used to characterize the current water quality. Water quality data in the confined aquifer are regionally limited to just those monitoring wells constructed near the City.

Groundwater in the Tracy Subbasin is, for the most part, of decent quality. Locally, some problem constituents include TDS, nitrates, boron, chloride, and sulfate. The following sections discuss these problem constituents, contamination, and their relationship to the aquifers and sediments.

3.2.11.1 Total Dissolved Solids

TDS is a measure of the amount of salts in the water. The TDS concentrations in the unconfined aquifer (1968 data) range between 567 and 2,310 mg/L. The TDS concentrations increase toward the rivers and to the west. The 2005 TDS concentrations are similar in

pattern to the 1968 data, with better quality water along the southern margin of the subbasin. The groundwater flow direction in the unconfined aquifer for 2005 shows the groundwater is flowing from the southern portion of the subbasin northward toward the Delta. The groundwater flow direction, in combination with the source of the high quality water, is from the southern margin of the valley. Corral Hollow and Hospital Creeks, along with potential leakance from the Delta-Mendota Canal (DMC) and CVP canals, are potential sources of low TDS recharge to the unconfined aquifer.

TDS concentrations for the confined aquifer are limited to production wells with long screens owned by the City, a community supply well, Santos Ranch Water System, and short screen monitoring wells owned by the City. The TDS concentrations in aquifers below the Corcoran clay range from 300 to 1,100 mg/L. The best quality water is from sediments immediately below the Corcoran clay. There is no consistent pattern, but generally with depth, the water quality degrades.

3.2.11.2 Sulfate

Sulfate (which is a component of TDS) concentrations in the unconfined aquifer, based on 1968 data, show a similar distribution as TDS. The concentrations are the lowest near the airport and increase toward the north and east. The concentrations range from less than 100 to over 300 mg/L. For the City, sulfate concentrations of 93 mg/L to 137 mg/L were found in their monitoring wells.

Although the monitoring wells are showing concentrations of sulfate below the maximum contaminant level (MCL), production wells operated by the City commonly have elevated levels of sulfate. This suggests the sulfate is not coming horizontally through the aquifers but may be from either the unconfined aquifers or from upwelling of groundwater from lower aquifers.

3.2.11.3 Chloride

Chloride is also a component of TDS. Chloride concentrations in the unconfined aquifer range from 50 to 850 mg/L, with lowest concentrations near the Coast Ranges south of Tracy near the airport. The highest concentrations occur to the east and northwest. Groundwater quality data from the City monitoring wells in the confined aquifer have chloride concentrations of 60 to 500 mg/L.

3.2.11.4 Nitrate

Nitrate is an essential element for plant growth. However, some permanent crops may be adversely affected by excess nitrate. High nitrate levels are also detrimental to human health. Drinking water standards establish an MCL of 45 mg/L nitrate (as nitrate). Nitrate (as nitrogen) concentrations in the confined aquifer are low, below the MCL for drinking water.

3.2.11.5 Boron

Excessive amounts of boron in groundwater may be from several sources. Groundwater in volcanic areas and water of many thermal springs contain elevated concentrations of boron. Boron may be liberated from, or contained in, volcanic gases. Marine sediments may also contain boron either as a residual from contact with ocean water or as connate water. Ocean water has about 4.6 mg/L of boron. Boron can negatively affect some plants such as fruit trees, grapes, and nuts at levels of about 1 mg/L (Hem, 1989).

Boron concentrations in the unconfined aquifer, based on the 1968 data, range from 0.7 to 6.3 mg/L. The lowest concentrations again follow a similar pattern as the TDS, with low concentrations next to the Coastal Range foothills. No boron data were available for the unconfined aquifer in 2005.

Boron concentrations in the confined aquifer are generally between 0.8 to 1.2 mg/L with the exception of the monitoring well location (southwest side of the City) where the concentrations reach 2.1 mg/L. The highest boron concentrations occur where the highest sulfate water is present and seem to be related.

3.2.12 Groundwater Use

Groundwater pumping occurs throughout the Tracy Subbasin, south of Old River, with the greatest concentration occurring in and around the City and in agricultural areas that do not have access to surface water supplies. Agricultural areas with access to surface water may pump groundwater to supplement surface water supplies.

3.2.13 Soil Characteristics and Surface Recharge Potential

Surface recharge potential in the Tracy Subbasin is a function of soil type. The surface recharge potential of the soil was interpreted based on the hydrologic soil group as categorized by the Natural Resources Conservation Service (NRCS). Hydrologic soil groups are classified according to their ability to infiltrate water and affect runoff. The soils are grouped according to the amount of water infiltration when the soils are thoroughly wet and receive additional precipitation. The four hydrologic soil groups are:

Group A: Soils having a high infiltration rate (low runoff potential) when thoroughly wet

Group B: Soils having a moderate infiltration rate when thoroughly wet

Group C: Soils having a slow infiltration rate when thoroughly wet

Group D: Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet

Figure 3.11 shows the hydrologic soil groups in the Tracy Subbasin. The area associated with soils with highest infiltration rate (Group A) is along Corral Hollow. In general, Group B soils (i.e., those with moderate infiltration rate) are located in the southwestern areas of the Tracy Subbasin and along Old River. The predominate hydrologic soil type, north of Old River, is Group C. The remaining soil type in Tracy Subbasin, south of Old River, has a low infiltration rate (Group D).

3.3 Land and Water Uses within Plan Area

Water demands vary by land use and crop type. This section summarizes current and future land and water demands. Current land use and water demands were analyzed using the most recent land use survey (1996) for San Joaquin County completed by the California Department of Water Resources. Future land use and water demand were developed using estimates of expected land use at the current sphere of influence (SOI) for the City.

3.3.1 Existing Land and Water Use

Figure 3.12 shows the generalized 1996 crop type in the Tracy Subbasin. The figure includes delineation of urban areas as they currently exist and the projected SOI for the City. Table 3.1 estimates the total water demand, which is met by a combination of groundwater and surface water supplies for this land use distribution. The water demand was estimated by applying water duty factors to each type of land use and specific crop type found in the Tracy Subbasin.

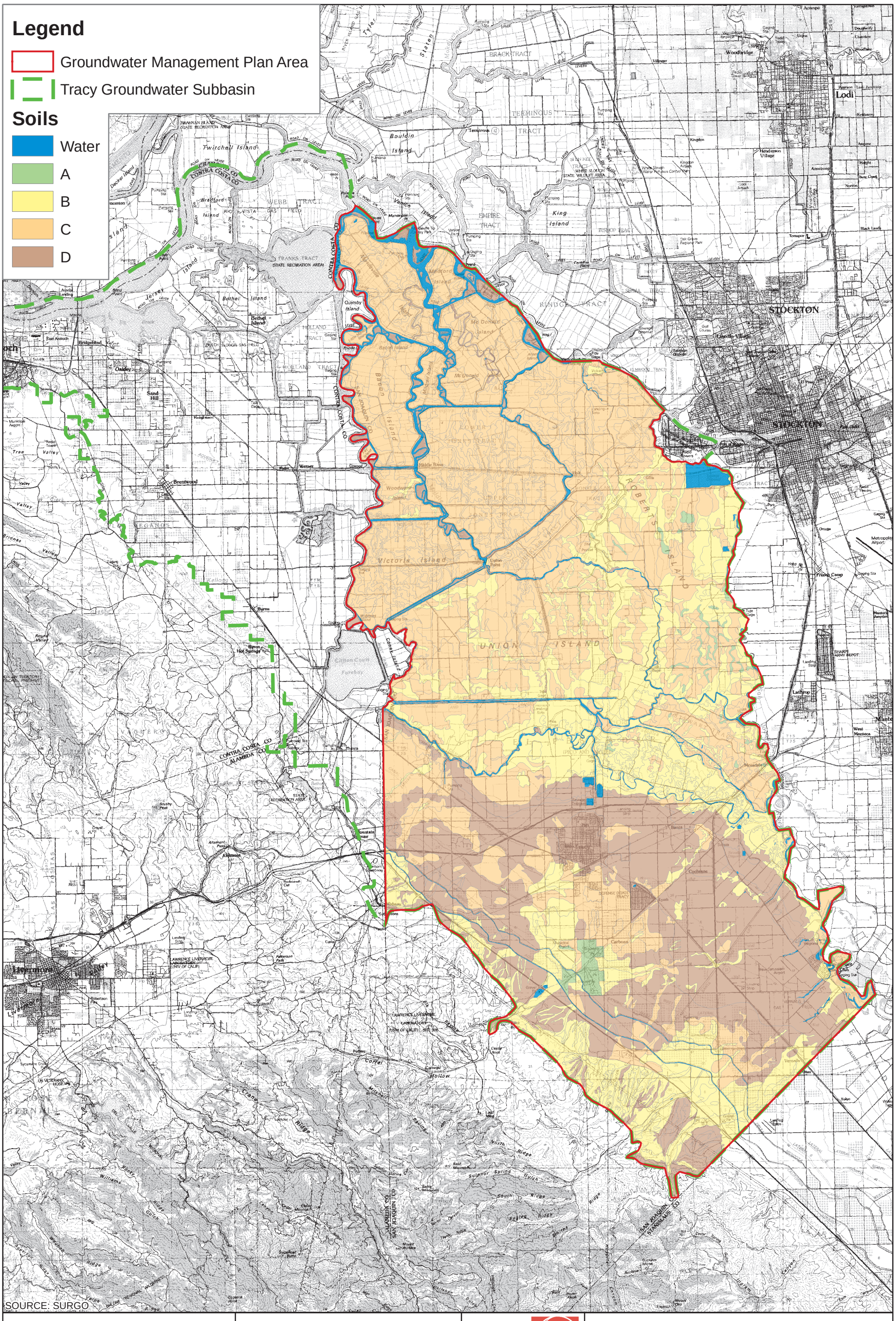
Table 3.1. Summary of Tracy Subbasin Land Use and Demand

	Area			Water Demand (AF)
	Agriculture (acres)	Undeveloped (acres)	Urban (acres)	
1996 Land Use	174,000	45,000	15,200	520,400
Tracy LAFCO Build-Out Conditions	156,700	37,600	39,900	519,800

In 1996, agricultural land use in the Tracy Subbasin totaled approximately 74 percent of the area, with about six percent is in urban use. The remaining 20 percent of land area is undeveloped. Agricultural water demand in the Tracy Subbasin was estimated to be 93 percent of total water demand (total water demand is approximately 520,400 acre-feet).

3.3.2 Projected Land and Water Use

Projected land use and water demand data were developed for build-out conditions for the City. The primary change in land use is the conversion of agricultural and native lands to urban development near or adjacent to the City. The City's General Plan was updated in



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2 1 0 2
Miles

N W E S

Tracy Regional
Groundwater Management Plan

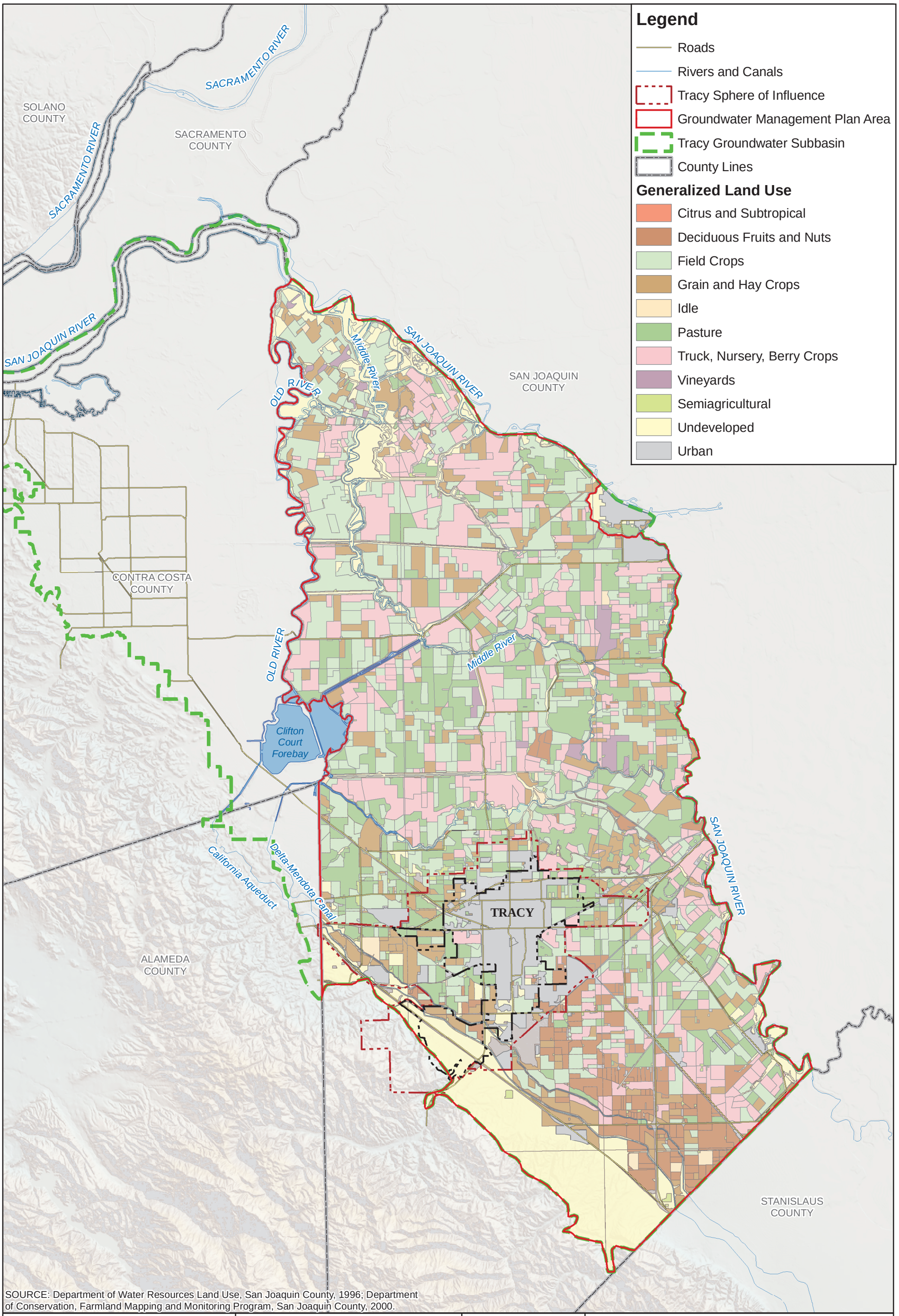
San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

Hydrologic Soil Types
in the Tracy Groundwater Subbasin

JANUARY 2007

FIGURE 3.11



SOURCE: Department of Water Resources Land Use, San Joaquin County, 1996; Department of Conservation, Farmland Mapping and Monitoring Program, San Joaquin County, 2000.

2 1 0 2
Miles

N W E S

Tracy Regional Groundwater Management Plan

San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

1996 Land Use with 2000 Urban Lands

JANUARY 2007

FIGURE 3.12

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2006. The projected land use was based on information obtained from the San Joaquin County Local Agency Formation Commission (LAFCO). The San Joaquin County LAFCO works with cities in San Joaquin County and with departments in San Joaquin County government to develop SOIs that define boundaries for urban growth. Using the LAFCO data for the Tracy Groundwater Subbasin, it is expected that urban area will expand by 24,700 acres from 1996 conditions.

For projected agricultural land use conditions, the current crop mix was assumed to remain unchanged from current conditions. Based on the analysis of projected land use data, the agricultural area is expected to reduce by approximately 17,200 acres. Urban area is expected to increase by 24,700 acres by urbanizing undeveloped area and agricultural lands. The change in land use represents an 8 percent reduction in total agricultural area and an increase of 280 percent in urban development from current conditions. There is corresponding change in water demand with the changes in land use. Future agricultural water demand for the Tracy Subbasin is estimated to be 83 percent of the total water demand of 520,000 acre-feet. It is expected that the total water demand for the Tracy Subbasin will not appreciably change from current conditions. However, this does not account for urban development that may occur outside the City SOI.

3.4 Climate – Rainfall and Evapotranspiration

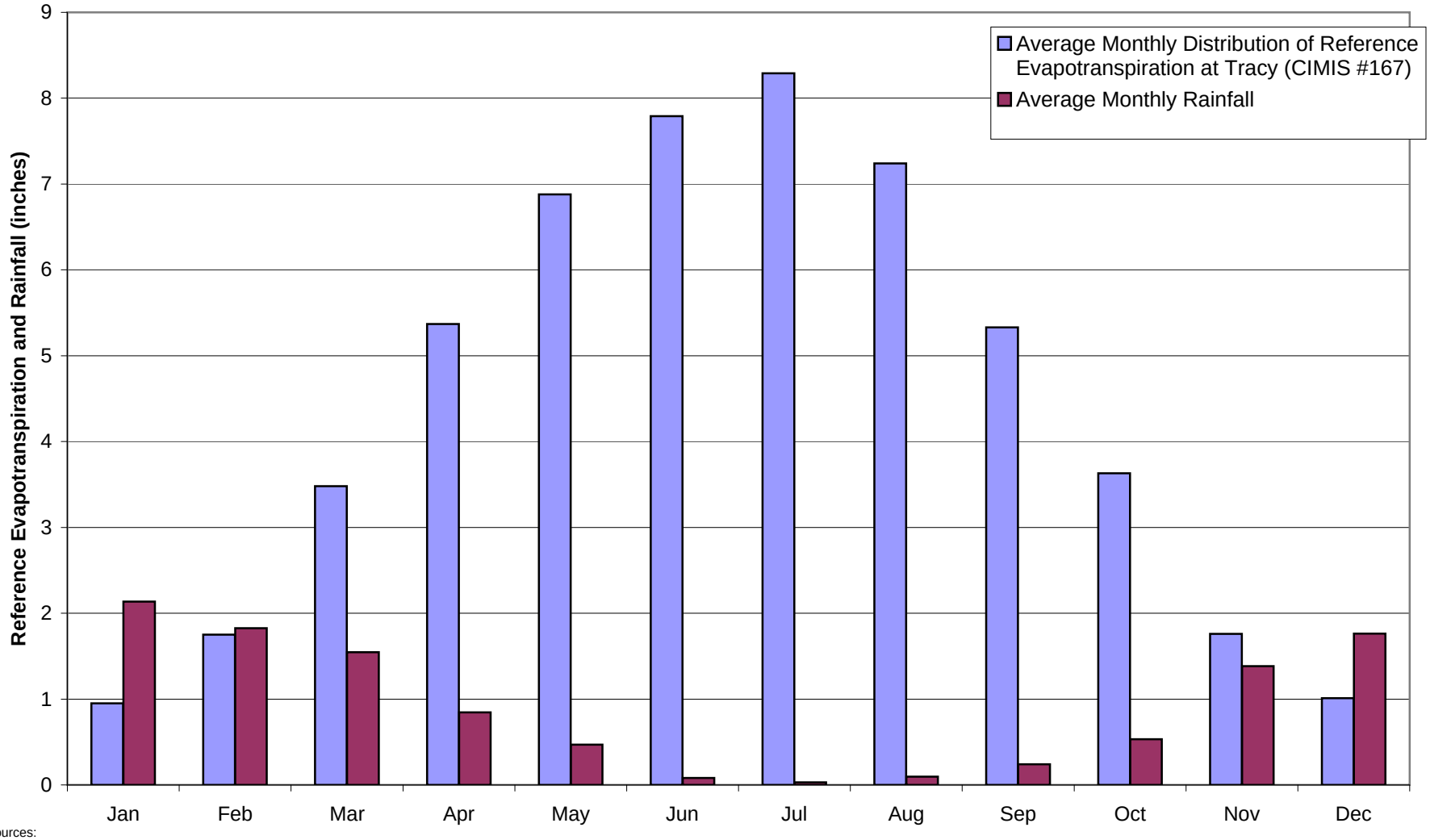
The climate in the Tracy Subbasin is semi-arid, with mild winters and hot, dry summers. Typical annual rainfall ranges from about 9 to 11 inches per year, with most of the rainfall occurring in winter and spring. Figure 3.13 shows the average monthly distribution of rainfall at the National Climatic Data Center (NCDC) Tracy Carbona station, which is located near the City. The rainfall record at this station is assumed to be representative of the Tracy Subbasin.

Figure 3.13 shows the average monthly reference evapotranspiration (ET) at the Tracy (#167) California Irrigation Management Information System (CIMIS) station. Reference ET is used by growers to determine crop water needs and schedule irrigation. Water use of specific crops varies, but reference ET provides a good general measure of crop water demands. Comparing rainfall to ET shows that precipitation in the Tracy Subbasin does not provide water for crops at times or in the amounts needed to meet crop water demands. The difference between rainfall and ET represents the crop water demand that must be met with applied water. In the Tracy Subbasin this applied water is either delivered surface water or pumped groundwater.

3.5 Urban Water Purveyors in the Basin

Table 3.2 lists water-related agencies in the Tracy Subbasin lists the potential water supply types for each agency.

Figure 3.13 Average Monthly Reference Evapotranspiration and Rainfall at Tracy



Sources:
Reference Evapotranspiration - California CIMIS Tracy Station (#167)
Rainfall - UC Davis Integrated Pest Management, Tracy-Carbona Station

Table 3.2. Summary of Urban Water Supplies

	Source	Contract #	Duration (years)	End Date	Depletion Schedule	Dry Year (acre-feet/year)	Normal Year (acre-feet/year)
City of Tracy – Existing Supplies (Year 2007)	USBR	14-06-200-7858A	40	2014	M&I	7,500	10,000
	BCID	14-06-200-4305A	40	2044	Agricultural	1,250	5,000
	WSID	7-07-20-W0045-B	40	2044	Agricultural	625	2,500
	SCSWSP		Indefinite		None	9,000	10,000
	Groundwater *					Up to 9,000	4,000
	TOTAL					27,375	31,500
City of Tracy - Expected Additional Supplies (After Year 2007)	BBID	Delivery of pre-1914 appropriative water rights	- -	- -	n/a	4,050	4,500
	BBID	Acquisition of CVP contract rights	- -	- -	Agricultural	2,750	6,400
	WSID	Assignment of CVP Contract	- -	- -	Agricultural	625	1,500
	TOTAL				12,400	7,425	12,400
Mountain House CSD	BBID	Pre-1914	Indefinite		None	Up to 9,413	Up to 9,413
Patterson Pass Business Park - CSA 50	BBID	Wholesale Agreement			M&I	800	550
All other CSA/CSDs	No surface water supply						

* Groundwater operational yield is 9,000 af/yr, consistent with the City's Groundwater Management Policy. Annual groundwater pumping is dependent on actual demand and hydrologic conditions.

3.5.1 City of Tracy

The City is located in western San Joaquin County about 15 miles southwest of Stockton, California. It overlies the southern part of the Tracy Subbasin as defined by DWR and historically has used groundwater to meet its municipal and industrial (M&I) water needs. The City receives surface water supplies from the U.S. Bureau of Reclamation (USBR) and South San Joaquin Irrigation District (SSJID) to help reduce its use of groundwater. Average water demand, as calculated from 2000-2004, is 16,400 acre-feet. The build-out water demand for the City is estimated to be 35,700 acre-feet.

The City entered into a 40-year contract with the USBR in 1974 for 10,000 acre-feet of water per year. The City has an assignment from BCID for 5,000 acre-feet of their CVP contracted amount. The City also has an assignment of 2,500 acre-feet per year from West Side Irrigation District (WSID).

The City also receives water from the South County Surface Water Supply Project (SCSWSP). The SCSWSP supplies Stanislaus River water to the Cities of Manteca, Escalon, Lathrop, and Tracy using SSJID pre-1914 water right water. The City has been allocated 10,000 acre-feet per year. The City started taking Stanislaus River water in August 2005.

A recent assessment of the aquifer system beneath Tracy indicates an average operational yield of 9,000 acre-feet per year is sustainable without adverse impacts to the groundwater resources or quality in the Tracy area. The City's Groundwater Management Policy supports the use of up to 9,000 acre-feet per year of groundwater as needed to meet the total water demand. The annual groundwater use is dependent upon demand and annual hydrologic conditions. For example, the City's groundwater use has been reduced in recent years from over 7,000 acre-feet per year to about 4,000 acre-feet per year as the additional surface water supplies described above have come online and in 2006, the City reduced its groundwater pumping to about 3,000 acre-feet. The City is currently planning to reduce their groundwater pumping at build-out to 2,500 acre-feet per year in normal hydrologic year types.

The City is planning to start an aquifer storage and recovery program where high quality water is injected into the confined aquifer and stored. The water is later pumped out and treated. The City is awaiting a permit from the Central Valley RWQCB to start the program.

The City has been requested to provide water service to areas outside their municipal boundary. Implementing these requests has posed a significant burden on the City.

3.5.2 Mountain House Community Services District (CSD)

Mountain House CSD encompasses the master planned community of Mountain House. The master plan was approved in 1994 and construction started in 2001. It is anticipated that construction will be completed in 2021, at which point it will provide housing for 44,000. Mountain House water supply is provided by BBID by use of their pre-1914 appropriative water rights. The total supply amount is 9,413 acre-feet per year. Mountain House does not pump groundwater for municipal purposes.

3.5.3 Patterson Pass Business Park – County Service Area (CSA) 50

Patterson Pass Business Park has a wholesale agreement with BBID for 800 acre-feet of water per year during dry years and 550 acre-feet during normal years.

3.5.4 Other County CSA/CSD

Several other CSA/CSD pump groundwater to serve small municipal areas. Pumping data for these CSAs/CSDs were not available.

3.6 Agricultural Water Purveyors

There are several agricultural water purveyors in the southern area of the Tracy Subbasin. These agricultural water purveyors are briefly described below.

Table 3.3 shows the acreage for six generic crop types in the Tracy Subbasin as reported in the 1996 San Joaquin County DWR Land Use Survey. DWR conducts county-wide land use surveys every 6 to 10 years. In their surveys, the particular crop type for each land parcel is identified. In Table 3.3, these particular crop types have been generalized into six generic crop types.

Table 3.3. 1996 Crop Acreage for Tracy Subbasin Irrigation Districts

Crop Type	Area (acres)					
	BCID	BBID	WSID	WStID	DPWD	NBID
Deciduous	5,250	500	100	140	4,020	0
Field	3,040	2,210	1,690	110	940	740
Grains	1,580	2,150	1,250	80	780	360
Pasture	2,000	2,720	2,260	0	120	930
Truck	3,340	280	400	1,540	240	70
Total	15,210	7,860	5,700	1,870	6,100	2,100

3.6.1 Banta-Carbona Irrigation District

BCID is an agricultural water purveyor in the Tracy Subbasin serving approximately 18,000 acres of agricultural land. BCID water supplies consist of a pre-1914 water right, two licenses, and a CVP DMC supplemental water contract, the pre-1914 water right and two licenses entitle the district to divert up to 204 cubic feet per second (cfs) from the San Joaquin River in the south Delta, and the CVP contract is for up to 20,000 acre-feet per year from the DMC as hydrologic conditions permit. There are some production wells located in some areas of BCID, though they tend to be used only under drought conditions as the water contains boron and some salts.

3.6.2 Byron-Bethany Irrigation District

BBID was formed in 1919 and was reorganized in 2004 to annex the area of the Plain View Water District. The district encompasses approximately 29,000 acres within Alameda, Contra Costa, and San Joaquin Counties and covers five service areas; the Byron and Bethany Agricultural Service Areas; Raw Water Service Area 1, serving the community of Mountain House; Raw Water Service Area 2; a future urban area within the City; and the CVP Service Area formerly the boundary of Plainview Water District. Table 3.3 shows the acreage for six generic crop types in BBID where the total irrigated acreage is 7,900 acres.

BBID's water supply is based upon a pre-1914 water rights established by BBID. The BBID asserts claim under this pre-1914 water right for the reasonable and beneficial use of 60,000 acre-feet per year. In exchange for operational certainty, the BBID has agreed to limit the annual diversion from the Delta to 50,000 acre-feet per year at a rate not to exceed 300 cfs through an agreement with DWR.

3.6.3 The West Side Irrigation District

TWSID began operations in 1918 with diversions made from Old River. Table 3.3 shows the acreage for six generic crop types where the total irrigated acreage is approximately 5,700 acres. TWSID has a 1916 water right to Old River of 82.5 cfs between April 1 and Oct 1. It became A CVP DMC contractor in 1977 and has contracted for 5,000 acre-feet of M&I scheduled water through 2030. TWSID also has an assignment on behalf of the City for 2,500 acre-feet per year. The district encompasses an area of approximately 6,800 acres with a significant portion located within the City SOI. Private wells within TWSID account for all groundwater pumping within its service area.

3.6.4 Naglee-Burk Irrigation District

Naglee-Burk Irrigation District (NBID) has pre-1914 appropriative rights to Old River with an approximate annual supply of 9,300 acre. Table 3.3 shows the acreage for six generic crop types where the total irrigated acreage in NBID is approximately 2,100 acres. The district encompasses an area of approximately 2,900 acres of which most is used for agricultural purposes. Private wells within NBID account for all groundwater pumping within its service area.

3.6.5 Del Puerto Water District

Del Puerto Water District (DPWD) was formed in 1995 when 11 separate water districts were aggregated. The resulting 54,500-acre water district includes portions of San Joaquin, Stanislaus, and Merced Counties. Table 3.3 shows the acreage for six generic crops where the total irrigated acreage in DPWD is approximately 6,100 acres. The DPWD has a CVP contract for 140,200 acre-feet of water per year. The expiration date of the contract is 2030. There are private wells within DPWD that are used for irrigation purposes.

3.6.6 West Stanislaus Irrigation District

West Stanislaus Irrigation District was formed in 1920 and started diverting water from the San Joaquin River in 1929. The district is comprised of approximately 22,500 acres of irrigated farmland of which 2,000 acres are located in the Tracy Subbasin. Diversions from the San Joaquin River were replaced, in part, with diversions from the DMC. The district has a 50,000 acre-feet per year contract with the USBR to divert water from the DMC on an M&I schedule. This contract expires in 2030. Although Delta water typically is of better quality than San Joaquin River water, the district typically diverts its maximum allocation from the

San Joaquin River. The district operates a groundwater pumping program. Groundwater is also pumped by private well operators.

3.7 Industrial Water Users

3.7.1 Army Depot

The 448-acre Tracy Army Depot site was opened in 1942. Operations at the site include repacking leaking chemical containers, fumigating shipping materials, maintaining vehicles, painting, storing chemicals, preserving metal parts, operating chemical and photographic laboratories, storing and mixing pesticides, and storing and treating liquid and solid wastes. Liquid waste treatment and storage areas included unlined ponds, lagoons, trenches, and burn pits. Solid waste treatment included several burial sites. Waste disposal practices resulted in the contamination of the nearby unconfined aquifer. The primary contaminants were volatile organic compounds (VOCs) and specifically trichloroethylene (TCE), tetrachloroethylene (PCE) and 1,2-dichloroethane (DCE). In 1980, groundwater monitoring at the Tracy Army Depot detected trichloroethylene (TCE) and PCE at levels of 20 parts per billion (ppb). Elevated levels of PCE and TCE were detected offsite from the Tracy Army Depot. In 1990, Tracy Army Depot installed remediation measures to control off-site migration of TCE and PCE to 5 ppb. This remedial system will operate up to 30 years to meet remediation goals. Since 1999, the Tracy Depot treats approximately 600 acre-feet of groundwater per year and has treated over 1,200 acre-feet of the groundwater in a single year. TCE and PCE concentrations have declined from 88 and 198 ppb in 1999 to 33 and 40 ppb in 2005, respectively.

3.7.2 Mining Operations

There are seven active mining operations in the Tracy Subbasin. The quarries produce sand, gravel, and other aggregate. Three of the seven quarries are located at the Interstate 580 and Interstate 5 intersection, south of State Route 132. These quarries operate above historic groundwater levels in the area so groundwater use is incidental to quarry operations and not due to dewatering operations. The remaining quarries are located near and around the Tracy Municipal Airport.

4 Goals and Objectives

Understanding the available groundwater resources allows for informed decisions regarding meeting future water needs. Section 3 summarized the current and historical groundwater conditions. This section defines the goals and objectives established to improve and expand groundwater management opportunities in the Tracy Subbasin. Once broad goals have been established, qualitative objectives were set, and BMOs were developed to help measure progress. The goals and objectives established by the GAC are intended to help define GMP actions, plans, and strategies to be implemented. Members of the GAC have worked together to develop the goals and objectives, which are presented below.

4.1 Goal and Objectives

The groundwater level hydrographs for Tracy Subbasin show that groundwater levels are stable and that the Tracy Subbasin is full. The primary concern in the Tracy Subbasin is protecting and enhancing groundwater quality to ensure the long-term water supply reliability for agricultural and urban water users. Currently, local water demands do not exceed surface water and groundwater supplies with the current modes of management and use of existing facilities for water storage and distribution. However, the demand for high-quality groundwater is expected to increase with the increase of urbanization outside the City service area. It is not known whether the high-quality groundwater can be recharged in sufficient quantities to meet future local water demands.

The goals and objectives for this groundwater plan were established by the GAC early in the process to help establish and prioritize actions to solve the problems and to take advantage of opportunities. The GMP goal is a broad statement of the intent and purpose established by the local stakeholders. During early meetings of the GAC in the spring and summer of 2006, the committee identified the primary groundwater management issues and benefits of the implementation of a GMP. These were then used by the GAC to shape the GMP goals and the more specific objective statements. The overall goal of the GMP is:

> *To document the local approach of maintaining groundwater quality, increase flexibility of the operating the groundwater system, and ensure a sustainable groundwater system through development of specific projects and facilities to ensure long-term water supply reliability for the water users in the basin.*

The objectives were crafted to reflect the GAC values and priorities for meeting the GMP goal. The GAC expressed a strong desire to set objectives that would support developing feasible projects with reasonable costs. The proposed GMP objectives are to:

1. Prevent degradation of groundwater quality.

2. Establish rational and attainable BMOs for regional and specific areas, and to measure and track progress towards achieving basin goals.

3. Maintain local control of the groundwater basin by developing agreements and institutional arrangements that promote the responsible management of groundwater resources by overlying cities, water districts, agencies, companies, and landowners.

4. Continue coordinated groundwater management in the subbasin, including implementation of the recommendations of this GMP.

5. Implement monitoring programs that increase the understanding of the Tracy Subbasin, track progress toward meeting management goals, and improve subbasin management operational flexibility.

4.2 Basin Management Objectives

The State advocates the concept of local BMOs. BMOs allow objectives that are quantitative and measurable so that progress toward achieving the objective can be tracked and monitored. The BMO concept was also developed to meet the groundwater management needs within a basin that has different groundwater users and/or overlapping jurisdictional agencies. The BMOs for the Tracy Subbasin are specific to the management and groundwater conditions found in the subbasin.

Groundwater management must be adapted to an area's political, institutional, legal, technical constraints, and opportunities. The management objectives may be refined as more information is learned about managing the resource within that basin. Flexibility is key, and it must be operated within a framework that ensures public participation, monitoring, evaluation, feedback on management alternatives, rules and regulations, and enforcement (DWR, 2003).

Coupled with dedicated monitoring and reporting of the groundwater basin conditions, the BMOs will be used by the GAC to gauge the progress in meeting the GMP goals and objectives, and determine whether the anticipated benefits of the GMP are being achieved. In the future, the BMOs may be used by the GAC or responsible agencies to initiate subsequent management actions or respond to changing circumstances and new information.

To meet the purpose and goals of the groundwater management plan stated in Section 2, the agencies adopted the BMOs. Following is a presentation of the broad BMOs as well as a discussion of the more localized BMOs.

4.2.1 Manage Groundwater Levels

Except for some localized areas, groundwater levels in the basin are stable and the basin is generally "full." The increase in urban development is not expected to cause the groundwater table to lower if the growth does not occur in the groundwater recharge areas. This objective is intended to ensure that the overall groundwater levels in the basin are maintained to provide long-term reliable sources of water for the economic well-being of the area. Specific groundwater level management objectives include:

- Maintaining groundwater levels in the confined and unconfined aquifers to avoid long-term overdraft.
- Lowering shallow groundwater levels in the unconfined aquifer to reduce impacts to agricultural and municipal land uses
- Identifying, mapping, and protecting groundwater recharge areas.
- Identifying additional opportunities to increase water management flexibility through the conjunctive use of surface water and groundwater supplies.

4.2.2 Maintain and Improve Groundwater Quality

Water quality in the basin is generally adequate for agricultural use in the western portion of subbasin. Water quality becomes worse in the eastern part of the subbasin with high levels of TDS and boron in groundwater. The water quality generally improves with depth in the unconfined aquifer. In the confined aquifer, water quality generally declines with depth. The best quality water is generally located in the confined aquifer and typically near the upper portion of the confined aquifer. Specific water quality management objectives include:

- Protecting the water quality in the confined aquifer from poorer quality water in the unconfined aquifer by ensuring the proper construction of groundwater wells, including seals to separate the aquifer systems.
- Protecting groundwater from the migration of contamination sources by incorporating available groundwater quality data into groundwater management operations.
- Limiting upwelling of groundwater from the deeper aquifers that contain high concentrations of sulfate.

4.2.3 Protect Against Potential Inelastic Land Surface Subsidence

Historically, no land surface subsidence has been identified within the basin. Given the balanced nature of groundwater storage in the basin, potential future land subsidence is not expected. The specific land subsidence objectives include:

- Managing the groundwater basin to prevent land subsidence.
- Adjusting groundwater management activities if land subsidence resulting from declining groundwater level is identified.

4.2.4 Protect Against Adverse Impacts to Surface Water Flows

There is little information regarding the relationship and interaction between surface water and groundwater in the Tracy Subbasin. This information is needed to develop an understanding of the implications on the recharge/discharge areas and water quality conditions. GAC member agencies will coordinate with state and federal agencies regarding programs to collect this information. Specific objectives include:

- Monitoring river stage and nearby unconfined groundwater levels.
- Evaluating this information to understand the relationship between surface water flows and groundwater levels at specific locations to determine the effect on groundwater levels and quality.

4.2.5 Groundwater Monitoring and Assessment

Groundwater monitoring provides the data and information needed to make groundwater management decisions. The agencies within the Tracy Subbasin who have participated in monitoring programs are aware of their importance to groundwater management. Current groundwater monitoring efforts include participation by various local districts, San Joaquin County, and DWR. Until the preparation of this GMP, there was no groundwater monitoring plan (Monitoring Plan) for the Tracy Subbasin that coordinated the efforts of the various entities. The Monitoring Plan developed for this GMP is included in Appendix E.

The Monitoring Plan identifies the extent of the existing groundwater monitoring program in the unconfined and confined aquifer systems for both water levels and water quality, and land subsidence. The Monitoring Plan was prepared based on the existing wells monitored by several different agencies in the basin, and provided recommendations for additional monitoring. This plan will be implemented by the GAC member agencies. Specific objectives include:

- Implementing the Monitoring Plan included in Appendix E.
- Discussing with DWR regarding reactivating monitoring at wells where well logs are available.
- Filling the data gaps in the Monitoring Plan with new dedicated multi-completion monitoring wells.

4.2.6 Coordinate with Other Agencies

The City and the other agencies participating in the GAC routinely coordinate on water resources matters within the basin. This coordination can be expanded to include additional water entities that have authority over issues that affect water management activities in the Tracy Subbasin. This expanded forum can be used to assist in the formulation of regional projects and programs for protection and use of subbasin water resources. Specific objectives include:

- Coordinating with water management agencies in San Joaquin County east of the San Joaquin River.
- Coordinating with local agencies with land use planning authority.
- Coordinating with small urban developments fully dependent on groundwater.
- Coordinating with state and federal agencies.

4.3 Geographically Specific Basin Management Objectives

This section describes the application of the BMOs described above to individual agencies in the Tracy Subbasin. They are presented to highlight local needs within the basin that were identified to develop the BMOs.

4.3.1 City of Tracy Area

The City relies on a combination of surface water and groundwater to meet the water demands within its service area. The groundwater supply has elevated TDS levels (300 to 1,100 mg/l) and requires the blending of surface water. The City is looking to improve its operational flexibility of surface water and groundwater to meet current and future water demands while meeting its permit requirements.

4.3.2 Banta-Carbona Irrigation District Area

BCID delivers surface water for agricultural and urban uses in the subbasin. Individual growers supplement their surface water supplies with groundwater, especially in drier years when less surface water is available. In addition, some areas of the district are subject to shallow groundwater levels. BCID is looking to improve local groundwater level and groundwater quality conditions to improve their long-term groundwater supply reliability and provide greater operational flexibility.

4.3.3 San Joaquin County –County Service Areas

The CSAs in the Tracy Subbasin rely solely on groundwater for their water supply. In several cases, the available groundwater supplies do not meet drinking water requirements because of marginal groundwater quality. Several of the existing CSA's have been issued

water quality notices by the California Department of Health Services (DHS). The City has been approached by DHS to provide water service to these areas that are located outside their service area. The County is looking to improve groundwater quality conditions in the basin for existing CSA's and to support future growth that may occur in the unincorporated areas of the basin that do not have access to surface water.

4.3.4 Byron-Bethany Irrigation District (BBID)

BBID delivers surface water for agricultural and some urban uses in the subbasin. Because of their location, very little groundwater is used in the district. Individual growers supplement their surface water supplies with groundwater, especially in drier years when less surface water is available. Portions of the district are located near the recharge areas, and there may be opportunities to participate in projects to improve local groundwater recharge, which would improve local groundwater level and groundwater quality conditions to improve long-term groundwater supply reliability in the subbasin.

4.4 Current Groundwater Monitoring Activities

4.4.1 Water Level Monitoring

There are 30 wells in the Tracy Subbasin that have been measured since 2005. These wells are listed in Table 4.1 along with construction information and the aquifer associated with the wells. These wells are monitored by DWR and other agencies in the Tracy Subbasin. The GAC members, to some varying extents, monitor groundwater production, levels, and quality.

4.4.2 Water Quality Monitoring

Other groundwater monitoring conducted in the basin assesses releases of hazardous materials to the environment. These wells are typically near metropolitan areas and the resulting data are provided to the RWQCB. Data collected from these wells are extremely useful because they typically collect the first water encountered, which can be correlated with surface water gaging stations to evaluate the aquifer connectedness. The Groundwater Monitoring Report in Appendix E contains information regarding expanding the current list of monitoring wells and other recommendations for improving the groundwater monitoring program in the Tracy Subbasin.

4.4.3 Subsidence Monitoring

Land subsidence in the Central Valley has occurred in three areas with an aggregate area of about 4,000 square miles. Subsidence has occurred in the San Joaquin Valley area extending from Los Banos to Wasco, from Arvin to Maricopa, and in the Delta region east of Stockton. In the Sacramento Valley, subsidence has also occurred along the west side of the valley in Yolo, Solano, and Colusa Counties.

Subsidence can be elastic or inelastic. Elastic subsidence occurs when aquifers are pumped and the pore pressure is decreased. After recharge occurs and the heads increase, the land surface generally recovers. Inelastic subsidence results in permanent, irreversible declines in ground surface. Inelastic subsidence is of three types in the Central Valley: oxidation of peat, lowering of the artesian head in confined aquifer systems, and near-surface compaction of moisture deficient alluvial fan deposits above the water table (Poland and Evenson 1966). Subsidence can also occur in areas where water-level declines in unconsolidated aquifers allow mineral grains to permanently adjust to a denser arrangement (Borchers et al. 1998). The mechanisms of subsidence in unconsolidated aquifers are governed by groundwater levels. If the water levels drop below their lowest historic level, inelastic subsidence may occur. In these cases, inelastic subsidence is generally due to compaction in thick clay beds.

The GAC is in an area where no significant subsidence has been reported, although no specific studies have been conducted in the area. The potential for subsidence as a result of groundwater pumping is low, but the potential exists due to the presence of the Corcoran clay. Because of current and expected operations of the groundwater, the potential for subsidence in the area is low. However, subsidence monitoring should continue.

Table 4.1 Current Level of Monitoring Efforts

Well Name	Well Owner	Reference Point Elevation	Perforated Interval	Aquifer System
LMO65C	Tracy Army Depot		144-160	Unconfined
LM124C	Tracy Army Depot		147-157	Unconfined
LMO47C	Tracy Army Depot		123-134	Unconfined
02S4E09A001M	San Joaquin County	47	80-100	Unconfined
02S05E13N001M	San Joaquin County	24	115-135	Unconfined
01S05E35Q002M	San Joaquin County	8	225-245	Unconfined
03S06E03F002M	San Joaquin County	29	118-135	Unconfined
MW1	Dick's Exxon	28.37	Not Available	Unconfined
MW-2	7-11 #32262	25.32	7-17	Unconfined
MW-4B	Pombo Ranch	53.55	Not Available	Unconfined
MW-1	Deuel Vocational Institute	14.32	Not Available	Unconfined
MW-101	George's Service	85.84	Not Available	Unconfined
MW-5	Sinclair Trucking	75.88	Not Available	Unconfined
MW-2	Joe's Truck Plaza	13.68	Not Available	Unconfined
MW-8	Joe's Truck Plaza	14.55	23-38	Unconfined
MRL-2W	DWR	9.1	Not Available	Unconfined
GLWL-1W	DWR	4.4	Not Available	Unconfined
WELL BW-3	Spreckles Sugar	4.59	Not Available	Unconfined
WELL BW-4	Spreckles Sugar	10.12	Not Available	Unconfined
WELL WP-7	Spreckles Sugar	16.64	Not Available	Unconfined
Well BC-19	Georgia-Pacific	98.78	Not Available	Unconfined
Well BC-20	Georgia-Pacific	89.53	Not Available	Unconfined

Well Name	Well Owner	Reference Point Elevation	Perforated Interval	Aquifer System
Well MW-23	Georgia-Pacific	102.24	Not Available	Unconfined
MW-1B	City of Tracy	50.09	618-658	Confined
MW-1C	City of Tracy	51.20	748-788	Confined
MW-2A	City of Tracy	92.59	426-466	Confined
MW-2B	City of Tracy	92.53	634-674	Confined
MW-2C	City of Tracy	92.53	770-810	Confined
MW-3A	City of Tracy	137.86	382-402	Confined
MW-3B	City of Tracy	138.08	540-580	Confined
MW-3C	City of Tracy	138.22	770-810	Confined
MW-4A	City of Tracy	104.08	450-490	Confined
MW-4B	City of Tracy	102.75	680-700	Confined
MW-4C	City of Tracy	103.11	770-810	Confined
MW-5A	City of Tracy	48.39	406-446	Confined
MW-5B	City of Tracy	47.82	576-616	Confined
MW-5C	City of Tracy	48.06	770-810	Confined
MW-6A	City of Tracy	26.52	400-465	Confined
MW-6B	City of Tracy	26.65	590-630	Confined
MW-6C	City of Tracy	26.79	755-795	Confined

5 Groundwater Management Measures

A high priority of the GMP is protection of the groundwater resources. This will be accomplished through a series of actions that will be implemented by the GAC members and facilitated by the GAC. These actions are described below.

5.1 Identification and Management of Wellhead Protection Area

The purpose of wellhead protection is to protect the groundwater used as a public supply, thereby reducing the costly treatment otherwise needed to meet relevant drinking water quality standards. A Wellhead Protection Area (WHPA), as defined by the Federal Wellhead Protection Program established by Section 1428 of the Safe Drinking Water Act Amendment of 1986, is "…the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield." The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on subsurface geologic conditions, the direction of groundwater flow, pumping rates, and aquifer characteristics. WHPAs are not a common issue associated with agricultural practices and operations. However, in the Tracy Subbasin, because of the relationship between agricultural and municipal water uses, some important considerations in delineating WHPAs are as follows:

- Location of existing public supply wells
- Identification of probable locations of future public supply wells
- Present direction of groundwater flow
- Probable direction of future groundwater flow
- Construction characteristics of public supply wells (i.e.; perforated intervals and annular seals)
- Subsurface geologic conditions (i.e., restricting layers, confining beds, and other features)
- Rate of current groundwater flow
- Pumping from upgradient areas
- Potential sources of contamination

- Forecasted future land use
- Potential areas of water quality risk include:
- Areas without improved sewage collection systems
- Areas with leaky sewer pipes and septic systems
- Improperly abandoned wells
- Improper of use of agricultural chemicals
- Areas with potential for spills of hazardous materials

Identification of WHPAs is a component of the Drinking Water Source Assessment and Protection (DWSAP) Program administered by the DHS. DHS set a goal for all water systems statewide to complete Drinking Water Source Assessments by December 31, 2002. The City has completed their required assessments by performing the three major components required by DHS listed below.

- Delineation of capture zones around sources (wells)
- Inventory of Potential Contamination Activities (PCAs) within protection areas
- Vulnerability analysis to identify the PCAs to which the source is most vulnerable

Delineation of capture zones includes using groundwater gradient and hydraulic conductivity data to calculate the surface area overlying the portion of the aquifer that contributes water to a well within specified time-of-travel periods. Typically, areas are delineated representing 2-, 5-, and 10-year time-of-travel periods. These protection areas need to be managed to protect the drinking water supply from viral, microbial, and direct chemical contamination.

Inventories of PCAs include identifying potential origins of contamination to the DWSAP areas. PCAs may consist of commercial, industrial, agricultural, and residential sites, or infrastructure sources such as utilities and roads. Depending on the type of source, each PCA is assigned a risk ranking ranging from *very high* for such sources as gas stations, dry cleaners, and landfills, to *low* for such sources as schools, lakes, and non-irrigated cropland.

Vulnerability analysis includes determining the most significant threats to the quality of the water supply by evaluating PCAs in terms of risk rankings, proximity to the well being surveyed, Physical Barrier Effectiveness (PBE), and whether contaminants have previously been detected. PBE takes into account factors that could limit infiltration of contaminants including type of aquifer, aquifer material (for unconfined aquifers), well operation, and well construction. The vulnerability analysis is based on a scoring system that assigns point

values for PCA risk rankings, PCA locations within the wellhead protection area, and well area PBE. The PCAs to which drinking water wells are most vulnerable are apparent once vulnerability scoring is complete.

5.1.1 Actions

The GAC will facilitate the following actions:

- Request that member agencies provide vulnerability summaries from the DWSAP to be used for guiding management decisions in the basin.
- Contact groundwater basin managers in other areas of the state for technical advice, effective management practices, and "lessons learned," regarding establishing wellhead protection areas.

5.2 Regulation of the Migration of Contaminated and Poor Quality Groundwater

The migration of poor quality groundwater is of primary concern to the City and the irrigation districts as well as the Tracy Army Depot and the CSAs that pump groundwater. Also of concern is the localized contamination of groundwater by industrial point sources such as dry cleaning facilities, food processors, and the numerous fuel stations throughout the Tracy Subbasin.

While the GAC does not have authority or responsibility for remediation of this contamination, it is committed to coordinating with responsible parties and regulatory agencies to keep GAC members informed of the status of known groundwater contamination in the basin.

5.2.1 Actions

The GAC will take the following actions:

- Develop maps showing the top and bottom and extent of the Corcoran clay.
- Coordinate with the USGS, DWR, and San Joaquin County to expand the network of monitoring wells to provide additional water quality data for public supply wells.
- If detections occur in these monitoring wells, facilitate meetings between the responsible parties and potentially impacted member agency(ies) to develop strategies to minimize the further spread of contaminants. Specifically, the consideration of altering groundwater extraction patterns or altering production wells in the vicinity of areas of poor groundwater quality or pollutant plume to change the groundwater gradient.

- Provide a forum to share all information on mapped contaminant plumes and LUST sites. This mapping can be used to show where future production and monitoring should be located.
- Meet with representatives of the Central Valley RWQCB to establish a relationship and identify ways to have open and expedient communications regarding any new occurrences of contamination, particularly when contamination is believed to have reached the water table.
- Track upcoming regulations on septic systems, agricultural discharges, and other regulatory programs that pertain to water quality degradation.
- Consider a shallow groundwater pumping program to reduce groundwater levels and to create opportunities for controlling migration of poor quality groundwater.

5.3 Implementation of Well Construction Policies

The San Joaquin County EHD administers the well permitting program within the Tracy Subbasin. The well construction standards implemented by EHD are consistent with those recommended in State Water Code Section 13801. This section of State Water Code requires that counties, cities, and water agencies to adopt the State Model Well Ordinance as a minimum standard for well construction or a more rigorous standard if desired. The San Joaquin County EHD has enacted well ordinances adopting the *California Well Standards, Bulletin 74-81,* and all supplements for areas of the county. The San Joaquin County EHD staff also issue applications and review construction plans and specifications for wells drilled in the county. The EHD requires and maintains well logs and water well driller reports for constructed wells.

Operating permits for wells utilized for public drinking water are provided through either the DHS or San Joaquin County EHD, depending on the number of service connections. The DHS has jurisdiction over public water system wells with over 200 service connections. Wells that serve public water systems with fewer than 200 service connections fall under the jurisdiction of the county.

5.3.1 Actions

The GAC will facilitate the following actions:

- Ensure that all member agencies are provided a copy of the applicable county well construction ordinance and that they understand the proper well construction procedures.

- Coordinate with member agencies to provide guidance, as appropriate, on well construction to prevent creating conduits through regionally confining beds. Where feasible and appropriate, this could include the use of USGS lithologic data prior to construction of the well to assist in well design.

5.4 Administration of Well Abandonment and Destruction Programs

It is believed that there may be many unknown, obsolete, or abandoned water supply and natural gas wells within the Tracy Subbasin. These wells may provide potential locations as a source of contamination between aquifers or from saline water sources at depth.

One of the primary concerns of local agencies is the groundwater contamination risk posed by unused wells that have not been properly destroyed. Section 21 of DWR Bulletin 74-81 and revisions contained in Part II of Bulletin 74-90 allow classification of unused wells into two types: abandoned and inactive. An abandoned well is defined as one that has not been used for a period of one year and whose owner has declared the well will not be used again. If the well has not been used during the past year but the owner demonstrates his/her intention to use the well again for supplying water, the well is considered inactive. Four criteria must be met in order for a well to maintain an inactive rather than abandoned classification. These criteria are:

- The well has no defects
- The well is securely covered
- The well is clearly marked
- The surrounding area is kept clear of brush and debris

Failure to meet these criteria could result in the well being classified as abandoned under current regulations. All abandoned wells, exploration or test holes, and monitoring wells must be destroyed as stated in Section 22 of Bulletin 74-81 and revisions contained in Bulletin 74-90.

An abandonment program should focus on those wells that pose the greatest threat to groundwater; however, numerous factors make the abandonment and destruction of wells difficult. These factors include lack of consistency in records regarding well construction, location, and use; cost of well destruction; and the defined classification for abandonment of wells. Well construction within the study area has taken place for nearly a century, with records and standards altered over time. Recent records pertinent to construction and location of new wells are more complete than earlier records that are often inconsistent. The lack of financial incentive for well owners to declare a well as abandoned also reduces the effectiveness of the well abandonment program.

San Joaquin County EHD administers the well destruction program for the Tracy Subbasin. The standards for construction are identified in the San Joaquin County code and are based on State of California standards.

5.4.1 Actions

The GAC members, including San Joaquin County and the City, should be take the following actions for lands within their jurisdictions:

- Ensure that all GAC members are provided a copy of the code and understand the proper destruction procedures and support implementation of these procedures.
- Follow up with GAC members on reported abandoned and destroyed wells to confirm information collected from DWR and receive information on abandoned and destroyed wells to fill gaps in county records.
- Obtain "wildcat" map from California Division of Oil and Gas to ascertain the extent of historic gas well drilling operations in the area because these wells could function as conduits of contamination if not properly destroyed.
- Seek funding to develop and implement a program to assist well owners in the proper destruction of abandoned wells.
- The GAC will communicate with San Joaquin County staff to determine the status of abandoned and destroyed wells and will coordinate with the county on the procurement of "wildcat" maps from the California Division of Oil and Gas.

5.5 Mitigation of Overdraft Conditions

The mitigation of overdraft is not an issue in the Tracy Subbasin. No actions are proposed at this time. However, the GAC will continue to monitor groundwater levels.

5.6 Replenishment of High Quality Groundwater Extracted by Water Producers

An important component of groundwater management is the protection of major recharge and withdrawal zones. This strategy has far-reaching effects in the Tracy Subbasin because of the limited area where recharge can occur for the confined aquifer. To ensure an adequate supply of high quality groundwater, groundwater recharge must be adequate to replenish extracted groundwater, while withdrawal zones need protection from upgradient sources to ensure that the quality of extracted groundwater meets the standards established for the intended use.

A comprehensive approach to the protection and management of the major recharge and withdrawal zones is needed to preserve and protect recharge areas. The GAC has evaluated surface geology within and directly adjacent to its boundary for the purpose of delineating areas having potentially high recharge rates. The basin contains an area of high recharge potential on the western edge of the subbasin. The GAC supports land use measures that will preserve potential recharge areas from development that would reduce or eliminate their effectiveness as recharge sites. These efforts will need to be coordinated with the San Joaquin County land use planning department or with other agencies associated with land use planning authority.

5.6.1 Actions

The GAC member agencies will take the following actions:

- Identify areas having high potential for contributing to aquifer recharge and encourage agencies to communicate with land use planning entities to enact measures that will protect these lands from development that would reduce their value as recharge sites.
- Construct monitoring wells and develop a groundwater level and quality monitoring program. Develop a monitoring program that correlates surface water flow and quality and groundwater levels and quality.
- Define local recharge areas that contribute to shallow groundwater and develop programs to manage shallow groundwater, which may include pumping shallow water for beneficial uses, lining sanitary sewer pipe in areas of high groundwater levels, and installing cutoff walls to provide hydraulic control of shallow groundwater levels.
- Communicate with DWR and other governmental agencies studying groundwater and river interactions.

5.7 Construction and Operation of Recharge, Storage, and Extraction Projects

Various GAC members share responsibility for development and operation of recharge, storage, and extraction projects. The GAC will promote cooperation and sharing of information between the agencies sponsoring water management projects and other member agencies. To the extent feasible, the GAC will also support measures to coordinate development and optimize operation of facilities to improve the basin-wide effectiveness and efficiency of water management.

5.7.1 Actions

The GAC will take the following actions:

- Encourage sharing of information on project planning, design, and operation among member agencies.
- Promote a coordinated approach toward project development and operation to lower the costs and increase the benefits of water management efforts.
- Seek funding for projects and programs that will contribute to recharge of the groundwater basin.
- Work with the Central Valley RWQCB to permit the City aquifer storage-recovery program.

5.8 Control of Saline Water Intrusion

Saline water intrusion from the San Joaquin River, from the marine layers, and from other native material is an issue in the Tracy Subbasin. Maintaining the positive groundwater gradient will prevent induced flow from the river or further migration of saline water.

5.8.1 Actions

The GAC coordinates with member agencies to take the following actions:

- Continue collecting groundwater quality data throughout the Tracy Subbasin and track the progression of saline water. This action will include communicating with DWR's District Office about including additional wells in the Tracy Subbasin so that TDS measurements can be taken. DWR has a regular program of sampling water quality in selected domestic, agricultural, and monitoring wells throughout the San Joaquin Valley, and additional wells in the Tracy Subbasin should be included. These wells can be augmented by additional monitoring wells to develop an early warning system able to detect saline water intrusion.
- The program of monitoring for intrusion of saline water will be included as part of other water quality monitoring efforts. The program includes provisions for monitoring groundwater levels and quality.
- Observe TDS concentrations in public supply wells that are routinely sampled under the DHS Title 22 Program.

6 Stakeholder Involvement

The City and the GAC initiated a planning process to prepare a regional GMP. This plan is developed to comply with provisions of the Groundwater Management Planning Act of 2002, including provisions related to public involvement processes.

6.1 Involvement of Other Agencies and Entities

The five agencies that initially formed the GAC included the City, BCID, BBID, Tracy Army Depot, and San Joaquin County Flood Control and Water Conservation District. These agencies share groundwater resources and worked together to formulate this management plan. The GAC provides coordinated planning to make the best use of available resources to the mutual interests of the inhabitants and resources of the groundwater subbasin. Throughout this planning process, other interested agencies and entities within the subbasin were encouraged and invited to participate in developing the plan. The GAC continues to work with member agencies and other entities to implement the components of this plan. The GAC should continue a proactive outreach effort to self-supplied groundwater producers and other small groundwater producers. This will include outreach to industrial and CSA groundwater users in the basin. The GAC will develop an outreach process to meet with the group and work together for more effective management of the water resources of the basin.

6.2 Coordination with Other Agencies

The GAC member agencies have coordinated the planning process with other neighboring water agencies and subbasins. Eastern San Joaquin County water interests have developed and are implementing a GMP and an Integrated Resources Water Management Plan. Delta-Mendota area water interests, the San Luis-Delta Mendota Water Authority (SLDMWA), are updating a GMP and GAC will meet with the SLDMWA to discuss coordination of their planning efforts. Several SLDMWA agencies are within the GMP area. Two of them, BCID and BBID, participate in the GAC. The GAC is in communication with the adjacent water interests and plans to provide draft copies of this management plan to the neighboring subbasins.

6.3 Groundwater Advisory Committee

The City formed the GAC with representatives of four agencies in the Tracy Subbasin to cooperatively work together to develop and adopt this GMP. They met the first or second Monday of each month to review the progress of the GMP during plan development, to discuss the water management issues of the basin, and to guide the planning process to develop the plan. Through detailed discussion, the GAC has developed BMOs and the GMP. This management plan is the result of the GAC work over a 12-month period.

6.4 Public Involvement

An extensive public involvement process was planned for developing the GMP. The components of the public involvement process included the following:

- The City published a notice informing the public of the intention of the agency to hold a public hearing to determine whether to adopt a resolution to prepare the Tracy Regional Subbasin Groundwater Management Plan.
- After the publication of notice of intent, the GAC sent out invitations to Tracy Subbasin water interests to participate in meetings regarding the planning process, schedule, content, and how the public can participate in the process and provide comments. Interested parties and the general public were invited and encouraged to attend the hearing and provide comments.
- Representatives of the GAC member agencies briefed their boards at their regularly scheduled public board meetings to keep them informed of the progress of the GMP.
- The governing bodies of the four GAC agencies scheduled a discussion of the draft GMP to provide information to the public as to the content of the draft plan, and to receive comments. Instructions were provided to the public for the submission of written comments.
- Public meetings were held to brief the public regarding the draft GMP and public comments were solicited. The GAC obtained the name, phone number, and the address of a contact person who provided written comments. The GAC then proceeded to prepare a final plan.
- Upon the completion of the GMP, a notice of intent was published in anticipation of the adoption of the plan to the GAC agencies with a recommendation to adopt the plan. A public hearing was conducted to receive comments.
- Upon completion of the GMP, a notice of intent was published in advance hearings to adopt the GMP by the GAC members. The notice included a summary of the plan and stated the means by which copies of the GMP could be obtained.
- Each GAC agency plans to hold a hearing to adopt the plan. Each agency will consider protests to the adoption of the plan. It is anticipated that there will no “majority protests,” and each agency will adopt the GMP.
- Detailed documentation of the public involvement processes is presented at the end of this chapter.

6.5 Developing Relationship with State and Federal Agencies

For the last several years, the water interests in the Tracy Subbasin have been working cooperatively with the USGS to study the geology and aquifers of the subbasin. The GAC and the USGS should consider entering into an agreement under the National Water-Quality Assessment Program to map the subsurface geology of the basin, develop a data network, and a three-dimensional model of the basin. The GAC agencies have ongoing relationships with USBR in that they are CVP contractors.

6.6 Dispute Resolution Process

The GAC meetings were used to identify and address water management issues in the basin. Discussion of issues in GAC the meetings, in an open and transparent process, resulted in a cooperative relationship between water users of the basin. The GAC will continue to provide a forum for identification and discussion of groundwater issues in the basin.

7 Plan Implementation

This chapter includes a discussion of program integration and local, statewide, and regional water management priorities and illustrates how the structure of the GMP addresses these priorities. It also addresses the specifics of plan implementation.

7.1 Integration of Local, State, and Federal Monitoring Activities

At present, a number of different agencies are responsible for different aspects of groundwater monitoring in the subbasin. One of the recommendations of the GMP is to continue the ongoing process of integrating local monitoring programs and improving access and management of groundwater data. Entities that are expected to be involved in this process include California DWR (state), USGS (federal), San Joaquin County DHS, and local water agencies. The objective of the recommendation is to have a groundwater monitoring and data management program that is comprehensive, efficient, and provides data in a format that is easy to access in order to facilitate recognition of problems and support good management decisions. The data collected from the implementation of monitoring plan will be made available to the interested entities.

7.2 Local, Statewide, and Regional Priorities

7.2.1 Local Priorities

The overriding local priority for implementation of the GMP is satisfying regional and local water management objectives as they are formulated through the development of BMOs. Through their involvement in the development of the GMP, participating agencies have demonstrated their conviction that the most effective approach to local water management is through regional actions. Specific local BMOs are discussed later in this section.

7.2.2 Statewide Priorities

Implementation of the GMP will enable the GAC and its member agencies to respond to a range of statewide water management initiatives. Key among these is the increasing emphasis placed on agencies to develop regional solutions to water management problems and to coordinate the conjunctive management of surface water and groundwater for sustainable water supply reliability and water quality in California.

The GMP also frames specific water management projects in the context of a regional water management strategy. Although the plan emphasizes groundwater management, elements of the plan address the use of surface water supplies to meet demands that have previously been met with groundwater. There is potential for the integration of surface and groundwater

resources, and this integration can lead to a more comprehensive management of water supplies and can provide a lucid framework for compliance with state and federal water quality standards.

7.2.3 Regional Priorities

Providing reliable good quality water for the water users in the basin is essential for the economic wellbeing and welfare of the citizens within the Tracy Subbasin. The GMP recognizes that the most effective approach to managing a basin's water resources is to enlist the cooperation of the agencies that share the same groundwater basin. As noted above, the GMP includes a number of regional BMOs that have been agreed upon by the participating agencies. The regional objective of the plan is to foster good stewardship of the resources and to promote wise management of regional resources that responds to regional and local BMOs.

7.3 Implementation Plan

The implementation plan presents specific management actions that enable the GAC to meet the BMOs. The purpose of the BMOs and the associated management action is to encourage a balance of surface water and groundwater use that will protect the resources of the basin and maximize the reliable supply of high quality water to meet municipal, agricultural, and industrial demands now and in the future. The BMOs reflect issues that the participating agencies have recognized as jeopardizing the reliability or quality of local water supplies. The management actions are designed to resolve these issues.

7.3.1 Basin-wide Recommendation Actions

A list of recommend actions is presented below by the BMOs presented in Section 4.

7.3.1.1 Identification of Natural Recharge Areas

Groundwater recharge from the surface occurs primarily along the western edge of the basin. Recharge due to applied water through this area may have been reduced over time because trends in agricultural irrigation practices have reduced deep percolation of applied water. Also, planned urban development in the Tracy Subbasin may impact natural recharge areas. These trends underscore the need to more precisely identify and map the remaining natural recharge areas and to use this mapping to protect important sources of recharge. The objective is to develop specific planning actions that offer varying degrees of protection, depending upon an area's significance as a source of recharge. Types of protection could include programs to educate public and planning entities about the importance of protecting recharge areas.

The first step in implementing this management action would be to identify recharge areas within the cities and the county, to develop a GIS-based map of natural recharge areas, to

inform planning entities of the importance of these areas, and to make recommendations for the protection of these areas.

7.3.1.2 Development of a Basin-Wide Water Budget

Development of a basin-wide water budget will provide essential baseline data on water needs and groundwater conditions, serve as a tool for assessing the likely impacts of proposed groundwater management actions, and enable an evaluation of how ongoing changes in land use and water management affect the basin's groundwater resources.

7.3.1.3 Feasibility Evaluation of Recharge Projects

The basin-wide water balance will illustrate trends in the balance between groundwater recharge and groundwater use. The water balance will probably demonstrate that the basin is full; however, there are recharge options available for sustaining and protecting basin recharge. Such projects could include expanded use of South San Joaquin Water Supply Project water and alternative uses of CVP supply by the City. In addition, this management action would continue to support the development and expansion of conjunctive use projects in urban areas with poor groundwater quality (i.e., supplement urban areas around the City with surface water in order to reduce its reliance on groundwater and prevent further migration of poor quality water).

7.3.1.4 Hydrogeologic Investigation

A hydrogeologic assessment was completed as part of the preparation of this GMP based on readily available data. Because most of the data available were from existing groundwater wells, there was limited information available from those areas with few or no wells. An expanded hydrogeologic investigation should be completed to supplement the existing information and fill data gaps. Specifically, the investigation would provide additional hydrogeologic information in key areas such as the potential recharge areas in the southwest part of the basin and provide dedicated multi-completion monitoring wells to the expand the monitoring program. Additional information developed, as part of this project would also support the evaluation of recharge projects.

7.3.1.5 Support of Public Health Programs

Well construction and demolition standards are designed specifically to protect groundwater quality. Management actions to assist local agencies in complying with public health standards include the following components:

Installation of sanitary well seals on all new wells in accordance with the California Well Standards.

Installation of wells that conform to San Joaquin County standards that include an impermeable seal between the upper and lower aquifers to prevent low quality water in the upper aquifer from entering the lower aquifer.

Abandonment of wells in accordance with the California Well Standards.

This management action will be particularly valuable in unincorporated areas not served by a water purveyor and could also apply to agricultural wells within the subbasin.

7.3.1.6 Water Quality Management

The protection of groundwater quality is a concern because the basin's population is growing and there is increased competition for potable water. A detailed geologic assessment of the basin focusing on the areas with poor water quality and identifying the sources of the poor quality should be conducted. This assessment would result in mapping recharge areas and development of strategies to control the migration and movement of poor quality water into and throughout the basin.

7.3.1.7 Groundwater Monitoring and Subsidence Monitoring Program

Groundwater monitoring and analysis and archiving of collected data are needed to implement several of the recommended management actions (e.g., conjunctive management and water quality management). Additional monitoring is needed to fill data gaps identified in the GMP and provide dedicated monitoring locations. It is also recommended that the GAC consider developing a database to facilitate the storage, retrieval, and archiving of groundwater data.

The GAC is considering plans to expand the monitoring and measurement the rate of inelastic land surface subsidence within the basin and specifically within the City.

7.3.1.8 Policy Assessment

Several of the technical management actions introduced above have clear policy requirements and implications. For example, effective protection of natural recharge areas will require coordination and communication with entities responsible for land use policies. Similarly, annexations to expand agencies' service areas as part of an in-lieu recharge program presume clear policies regarding annexation and a process to evaluate the impacts of annexation on groundwater levels and groundwater quality.

The development of consistent policies would be assisted by a regional groundwater forum such as the GAC. The purpose of this forum would be to foster coordination and cooperation among participating agencies to manage the Tracy Subbasin and to provide a framework for the formulation of regional projects and programs for the protection and use of subbasin water resources.

For example, given the mutual concern of agencies within the basin regarding the preservation of natural recharge areas and the protection of these areas from pollutants, local agencies could work through the forum to inform one another about land use practices that may contribute to groundwater degradation and the importance of reducing the occurrence of these land use practices.

7.3.1.9 Promoting Cooperation and Coordination between Water Entities

The GAC will continue to coordinate water management activities within the basin and to work cooperatively for implementation of agreed-upon BMOs. The GAC will also develop an outreach and educational program to engage other water interests for management of the basin. One example of such outreach will be working cooperatively with industrial water users to improve water quality in the basin.

7.4 Annual Implementation Report

Each year, the GAC will prepare a report describing the progress made in implementing management activities and the effects of these activities on meeting basin-wide and local management area BMOs. The report will include maps of spring and fall groundwater elevations and tabular summaries of ongoing management actions. The report narrative will present details of implementation activities and describe developments in the basin that are not part of the groundwater management plan implementation but that impact groundwater conditions in the basin (e.g., hydrologic conditions, siting of new industrial facilities, newly identified contaminant plumes, and trends on water quality).

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Appendix A

A. Tracy Subbasin Regional GMP Preparation Resolutions

September 5, 2006

AGENDA ITEM 5

REQUEST

RESOLUTION OF INTENTION TO ESTABLISH A TRACY REGIONAL GROUNDWATER MANAGEMENT PLAN

DISCUSSION

The City of Tracy received an AB303 grant from the California Department of Water Resources to prepare a regional groundwater management plan for the portion of the Tracy Groundwater Subbasin located within San Joaquin County. The City has contacted potential interested parties to notify them about the project and invite their participation in the project stakeholder group called the Groundwater Advisory Committee. A stakeholder meeting was held on July 13, 2006.

This project will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area. There is interest in ways the groundwater resources could be utilized as a dry year water supply for both agricultural use as well as municipal use. The objective of the planning process will be to develop groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002.

FISCAL IMPACT

There is no fiscal impact from adoption of this resolution of intention. Funding for the project is from a grant received by the City in the amount of $184,842.

RECOMMENDATION

That the City Council adopts a resolution of intention for the preparation of a Tracy regional groundwater management plan.

Prepared by Steve Bayley, Deputy Director of Public Works

Approved by Patrick Wiemiller, Director of Public Works

01-082506KL
PW

RESOLUTION 2006-222

RESOLUTION OF INTENTION TO ESTABLISH A TRACY REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, The City of Tracy received an AB303 grant from the California Department of Water Resources to prepare a regional groundwater management plan for the portion of the Tracy Groundwater Subbasin located within San Joaquin County, and

WHEREAS, The City has contacted potential interested parties to notify them about the project and invite their participation in the project stakeholder group called the Groundwater Advisory Committee, and

WHEREAS, A stakeholder meeting was held on July 13, 2006, and

WHEREAS, This project will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area, and

WHEREAS, The objective of the planning process will be to develop groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002, and

WHEREAS, There is no fiscal impact from adoption of this resolution of intention. Funding for the project is from a grant received by the City in the amount of $184,842;

NOW, THEREFORE, BE IT RESOLVED That the City Council hereby adopts a resolution of intention for the preparation of a Tracy regional groundwater management plan.

****

The foregoing Resolution 2006-222 was passed and adopted by the Tracy City Council on the 5th day of September, 2006, by the following vote:

AYES:	COUNCIL MEMBERS:	IVES, SUNDBERG, TOLBERT, TUCKER, BILBREY
NOES:	COUNCIL MEMBERS:	NONE
ABSENT:	COUNCIL MEMBERS:	NONE
ABSTAIN:	COUNCIL MEMBERS:	NONE

Dan Bilbrey
MAYOR

ATTEST:

Sandra Edwards
CITY CLERK

02-082506kl/PW

Appendix B

B. Tracy Subbasin Regional GMP Adoption Resolutions

NOTICE OF PUBLIC HEARING

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County are considering adoption of a regional groundwater management plan (GMP). To ensure stakeholder involvement throughout this process, the entities have formed a stakeholder group called the Groundwater Advisory Committee (GAC). The City of Tracy will hold a public hearing to decide whether to adopt this regional GMP.

This GMP addresses issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area. The GMP contains groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002.

Interested parties are encouraged to participate in this hearing and provide comments. The manner in which interested parties can participate in the planning process may include: (1) attending public hearings conducted by the City and other GAC members; (2) attending monthly public meetings scheduled throughout the planning process by the GAC; (3) requesting a draft of the plan and providing written comments to the City and GAC at the address below; (4) providing written comments throughout the planning process to the City and; (5) attending the future public hearings or meetings, which will be announced in the newspaper, and are intended to receive further comments on the GMP.

A public hearing will be held on March 6, 2007 at 7:00 p.m. at the Tracy Community Center, 950 East Street, Tracy, CA 95376. Written comments and communications with the City and/or GAC should be addressed to Mr. Steve Bayley of the City of Tracy and may be sent by any of the following methods:

Mail: City of Tracy, Public Works Department, 520 Tracy Boulevard, Tracy, CA 95376

Email: steveb@ci.tracy.ca.us

FAX: (209) 831-4472

Please Publish: Tuesday, February 20, 2007

02-021507kl
agenda:2007:February

RESOLUTION 2007-058

PUBLIC HEARING TO CONSIDER ADOPTION OF A TRACY REGIONAL GROUNDWATER MANAGEMENT PLAN

WHEREAS, The City of Tracy received an AB303 grant from the California Department of Water Resources to prepare a regional groundwater management plan for the portion of the Tracy Groundwater Subbasin located within San Joaquin County, and

WHEREAS, The City contacted potential interested parties to notify them about the project and invite their participation in the project stakeholder group called the Groundwater Advisory Committee, and

WHEREAS, The participants in the Groundwater Advisory Committee included the City of Tracy, Banta Carbona Irrigation District, Byron Bethany Irrigation District, San Joaquin County, Tracy Defense Depot, and the State Department of Water Resources, and

WHEREAS, A stakeholder meeting was held on July 13, 2006 and the City Council conducted a public hearing and adopted a resolution of intention to prepare a regional groundwater management plan on September 6, 2006, and

WHEREAS, The consultant has prepared the groundwater plan, with input from the Groundwater Advisory Committee, in compliance with Senate Bill 1938, the Groundwater Management Planning Act of 2002, and

WHEREAS, The groundwater management plan addresses groundwater levels, groundwater quality, cooperation and coordination between water entities, groundwater basin management objectives and measures to protect groundwater resources within the plan area, and

WHEREAS, The City of Tracy has available groundwater data, but fewer well sites have been monitored outside of the City. The groundwater management plan recommends expansion of the network of monitoring wells, and

WHEREAS, If Tracy adopts the groundwater management plan, it is anticipated that the plan may be adopted by some of the member agencies of the Groundwater Advisory Committee, and

WHEREAS, There is no fiscal impact from adopting this groundwater management plan. Funding for the project is from a grant received by the City in the amount of $184,842;

NOW, THEREFORE, BE IT RESOLVED That the City Council hereby conducts a public hearing and adopts the Tracy Regional Groundwater Management Plan.

* * * * * * * * * * *

The foregoing Resolution 2007-058 was passed and adopted by the Tracy City Council on the 3rd day of April, 2007, by the following vote:

AYES:	COUNCIL MEMBERS:	ABERCROMBIE, SUNDBERG, TOLBERT, TUCKER, IVES
NOES:	COUNCIL MEMBERS:	NONE
ABSENT:	COUNCIL MEMBERS:	NONE
ABSTAIN:	COUNCIL MEMBERS:	NONE

MAYOR

ATTEST:

CITY CLERK

02-022207kl
PW

Appendix C

C. Meeting Announcements

Notice of Stakeholder Meeting

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County intend to prepare a regional groundwater management plan (GMP). The City of Tracy will hold a public meeting to discuss the boundaries of the GMP and whether to prepare this regional GMP for the area. The City anticipates forming a stakeholder group called the Groundwater Advisory Committee (GAC) and welcomes other stakeholders.

This GMP will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area. The objective of the planning process will be to develop groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002. We are especially interested in ways the groundwater resources could be utilized as a dry year water supply for urban and agricultural uses.

Interested parties are encouraged to participate in this meeting and provide comments. The manner in which interested parties can participate in the planning process may include (1) attending public meetings conducted by the City and other GAC members, (2) attending public meetings to be scheduled throughout the planning process; (3) requesting a draft of the plan when it becomes available and providing written comments to the City and GAC at the address below; (4) providing written comments throughout the planning process to the City and; (5) attending the future public hearings, which will be announced in the newspaper, and are intended to receive further comments on the draft of the plan.

The stakeholder meeting will be held on July 13, 2006 at 7:00 P.M. at the Tracy Public Library, 20 E. Eaton Ave. Tracy, CA 95376. Written comments and communications with the City and/or GAC should be addressed to Steve Bayley, City of Tracy and may be sent by any of the following methods:

Mail: City of Tracy, Public Works Department, 520 Tracy Blvd., Tracy, CA, 95376

Email: steveb@ci.tracy.ca.us

Phone: (209) 831-4434

Fax: (209) 831-4472

PROOF OF PUBLICATION
(2015.5 C.C.P.)

STATE OF CALIFORNIA
County of San Joaquin

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a part to or interested in the above entitled matter; I am the principal clerk of the printer of the Tracy Press, a newspaper of general circulation, printed and published six times a week on Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday in the City of Tracy, California, County of San Joaquin, and which of newspaper has been adjudged a newspaper of general circulation by the Superior Court, Department 4, of the County of San Joaquin, State of California, under the date of June 30,1952, Case Number 53686; that the type not smaller than nonpareil), has been published in notice, of which the annexed is a printed copy (set in each regular and entire issue of said newspaper and no in any supplement thereof on the following dates, to-wit;

July 6

all in the year 2006

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated at Tracy, California, this 11th

day of July 2006

Signature

PROOF OF PU

This space is for the County Clerk's Filing Stamp

Proof of Publication

Public Notice # 654

City of Tracy

Notice Public Meeting

Notice of Stakeholder Meeting

PUBLIC NOTICE

No. 654

Notice of Stakeholder Meeting

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County intend to prepare a regional groundwater management plan (GMP). The City of Tracy will hold a public meeting to discuss the boundaries of the GMP and whether to prepare this regional GMP for the area. The City anticipates forming a stakeholder group called the Groundwater Advisory Committee (GAC) and welcomes other stakeholders.

This GMP will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area. The objective of the planning process will be to develop groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002. We are especially interested in ways the groundwater resources could be utilized as a dry year water supply for urban and agricultural uses.

Interested parties are encouraged to participate in this meeting and provide comments. The manner in which interested parties can participate in the planning process may include (1) attending public meetings conducted by the City and other GAC members, (2) attending public meetings to be scheduled throughout the planning process; (3) requesting a draft of the plan when it becomes available and providing written comments to the City and GAC at the address below; (4) providing written comments throughout the planning process to the City and; (5) attending the future public hearings, which will be announced in the newspaper, and are intended to receive further comments on the draft of the plan.

The stakeholder meeting will be held on July 13, 2006 at 7:00 P.M. at the Tracy Public Library, 20 E. Eaton Ave. Tracy, CA 95376. Written comments and communications with the City and/or GAC should be addressed to Steve Bayley, City of Tracy and may be sent by any of the following methods:

Mail: City of Tracy, Public Works Department, 820 Tracy Blvd., Tracy, CA, 95376

Email: stevebl@ci.tracy.ca.us

Phone: (209) 831-4434

Fax: (209) 831-4472

Publish: July 6, 2006

Notice of Public Hearing

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County are considering preparation of a regional groundwater management plan (GMP). To ensure stakeholder involvement throughout this process, the entities have formed a stakeholder group called the Groundwater Advisory Committee (GAC). The GAC in coordination with the City of Tracy will hold a public hearing to decide whether to prepare this regional GMP for the area.

This GMP will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area. The objective of the planning process will be to develop groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002.

Interested parties are encouraged to participate in this hearing and provide comments. The manner in which interested parties can participate in the planning process may include (1) attending public hearings conducted by the City and other GAC members, (2) attending monthly public meetings scheduled throughout the planning process by the GAC; (3) requesting a draft of the plan when it becomes available and providing written comments to the City and GAC at the address below; (4) providing written comments throughout the planning process to the City and; (5) attending the future public hearings or meetings, which will be announced in the newspaper, and are intended to receive further comments on the draft of the plan.

A public hearing will be held on September 5, 2006 at 7:00 p.m. at the Tracy Community Center, 950 East Street, Tracy, CA 95376. Written comments and communications with the City and/or GAC should be addressed to Mr. Steve Bayley of the City of Tracy and may be sent by the any of the following methods:

Mail: City of Tracy, Public Works Department, 520 Tracy Blvd., Tracy, CA, 95376

Email: steveb@ci.tracy.ca.us

Fax: (209) 831-4472

Please Publish: August 29, 2006

(2015.5 C.C.P.)

STATE OF CALIFORNIA
County of San Joaquin

I am a citizen of the United States and a resident of the County aforesaid; I am over the age of eighteen years, and not a part to or interested in the above entitled matter; I am the principal clerk of the printer of the Tracy Press, a newspaper of general circulation, printed and published six times a week on Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday in the City of Tracy, California, County of San Joaquin, and which of newspaper has been adjudged a newspaper of general circulation by the Superior Court, Department 4, of the County of San Joaquin, State of California, under the date of June 30,1952, Case Number 53686; that the type not smaller than nonpareil), has been published in notice, of which the annexed is a printed copy (set in each regular and entire issue of said newspaper and no in any supplement thereof on the following dates, to-wit;

August 29

all in the year 2006

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated at Tracy, California, this 6th

day of September 2006.

Signature

Proof of Publication

Public Notice #841

City of Tracy

Public Works Department

Notice of Public Hearing: Groundwater

PUBLIC NOTICE

No. 841

Notice of Public Hearing

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County are considering preparation of a regional groundwater management plan (GMP). To ensure stakeholder involvement throughout this process, the entities have formed a stakeholder group called the Groundwater Advisory Committee (GAC). The GAC, in coordination with the City of Tracy, will hold a public hearing to decide whether to prepare this regional GMP for the area.

This GMP will address issues related to groundwater quantity, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area. The objective of the planning process will be to develop groundwater basin management objectives as required by Senate Bill 1938, the Groundwater Management Planning Act of 2002.

Interested parties are encouraged to participate in this hearing and provide comments. The manner in which interested parties can participate in the planning process may include (1) attending public hearings conducted by the City and other GAC members; (2) attending monthly public meetings scheduled throughout the planning process by the GAC; (3) requesting a draft of the plan when it becomes available and providing written comments to the City and GAC at the address below; (4) providing written comments throughout the planning process to the City and; (5) attending the future public hearings or meetings, which will be announced in the newspaper, and are intended to receive further comments on the draft of the plan.

A public hearing will be held on September 5, 2006 at 7:00 p.m., at the Tracy Community Center, 950 East Street, Tracy, CA 95376. Written comments and communications with the City and/or GAC should be addressed to Mr. Steve Bayley of the City of Tracy and may be sent by the any of the following methods:

Mail: City of Tracy, Public Works Department, 520 Tracy Blvd., Tracy, CA 95376

Email: steveb@ci.tracy.ca.us

Fax: (209) 831-4477

Publish: August 29, 2006

PROOF OF PUBLICATION

Appendix D

D. Hydrogeologic Assessment Report

Hydrogeologic Assessment Report

for the Tracy Subbasin

Date: March 2007
Project No: 060260

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1 Introduction

This report describes the geology, aquifers, groundwater quality, and groundwater movement in the Tracy groundwater subbasin of the San Joaquin Valley groundwater basin. Although this groundwater management plan is only for the San Joaquin County portion of the subbasin, a more regional approach was necessary to understand the aquifer relationships and water quality. Therefore, the geology and hydrogeology of the entire subbasin are presented.

An extensive collection of drillers' logs was used to develop cross-sections defining the hydrogeologic framework of the subbasin and to define the vertical and lateral extent of the aquifers. Groundwater levels and water quality were obtained from existing wells to show the movement of groundwater to define areas of recharge and surface to groundwater interactions. Developing this understanding of where and how groundwater moves in the area will provide the basic framework to groundwater management areas and development of basin management objectives.

2 Hydrogeologic Assessment

This section describes the geology, aquifers, hydraulic characteristics, groundwater levels, and the direction of groundwater flow.

2.1 Hydrogeology

The Tracy groundwater subbasin is located in the northwest portion of the San Joaquin Valley, which is a structural trough about 200 miles long and 70 miles wide. The valley is filled with up to 32,000 feet of marine and continental sediments deposited during its periodic inundation by the Pacific Ocean and erosion of the surrounding mountains. Beneath the city of Tracy (City) there are over 3,400 feet of non-marine continental sediments (State Division of Mines, 1943). Only the upper 800 to 2,000 feet of these sediments contain water that is considered potable or suitable for drinking or agricultural use.

2.1.1 Geology

The subbasin is underlain by unconsolidated and consolidated sediments. In general, the geology consists of sediments eroded off the surrounding mountain ranges and at times have been transported the length of the San Joaquin Valley. The sediments are generally coarser grained in the western portion of the subbasin, having been deposited as coalescing alluvial fans and rivers from near the Coast Ranges and finer grained to the east and north.

The fresh water-bearing sediments beneath in the subbasin are grouped into recent alluvium (Qal), older fanglomerate (mf), and the Tulare Formation (QTt)(CGS, 2005). Underlying the Tulare Formation are the San Joaquin clays (SDMG, 1943). The clays are present at a depth of about 900 feet below ground surface (bgs) near the City. Figure 1 shows the location of these sediments and geologic profiles developed to show the extent and relationship of the sediments in the subbasin. Figures 2 through 7 show the geologic profiles.

Recent alluvium is generally found in the valley floor and along recent stream channels. The alluvium is generally thicker and finer grained in the valley and thins and is coarser towards the southwest as it approaches the Coast Ranges. In the valley, the sediments are associated with deposition from the San Joaquin and Sacramento Rivers and consist of sand layered with silt and clay. Figures 2 through 7 show the relationship of these sand layers to the current San Joaquin and Sacramento Rivers. The rivers in the western portion of the subbasin intersect some of the sand layers as shown on Figure 2. The sand appears to be relic river channels that meander and typically trend toward the west. Near the Coast Ranges, the coarser sediments have more of a northerly trend, as shown on Figure 3.

Underlying the recent alluvium is the Tulare Formation, the older fanglomerate, and the San Joaquin clays. The Tulare Formation is subdivided into an upper and lower portion that is separated by a thick regional clay bed known as the Corcoran clay. The upper portions of the Tulare Formation, along the southern margins of the subbasin, consist of fine- to coarse-grained floodplain, fan, and terrace deposits. The fan sediments consist of angular gravels mixed with sand, clay, and silt and are thicker near the southwestern margin of the subbasin and thin toward the center of the valley. In the central portions of the subbasin, the upper formation consists of clay, silt, and sand. Well drillers typically do not identify the change from the recent alluvium to the Tulare Formation.

The Corcoran clay formed in a large lake that extends from the Bakersfield area north to Tracy and is found mostly beneath the western half of the San Joaquin Valley. The Corcoran clay extends to just east of the San Joaquin River. Figure 8 shows the extent of the clay and elevation contours of the top of the clay (Page, 1986). The clay is about 60 to 100 feet thick in the Tracy subbasin. Near the Tracy airport (Production Well 2), the clay contains some gravel. It is possible that these sand and gravel beds (fanglomerates) interfinger with the Corcoran clay and may entirely replace the clay near the southern edge of the subbasin. Figures 2 though 7 show the extent and structure of the Corcoran clay based on geologic profiles and geophysical logs. The location of the Corcoran clay was initially defined at wells 3S/5E-5R1 and 2S/5E-22P1 from a U.S. Geologic Survey (USGS) file report (Hotchkiss, 1971) and Department of Water Resources (DWR) Bulletin 146 (DWR, 1967), respectively. The depth and location of the clay was then extended using geophysical logs (electric) from six monitoring wells constructed by the City. Figure 9 shows the electric log response to the Corcoran clay in two of the borings used to create the geologic sections. The depth of the clay as shown on the sections does not necessarily agree with the older projections of the elevation of the top of the clay that are shown on Figure 8.

The lower portion of the Tulare Formation is typically coarser than the upper portion of the formation. The sediments consist of sand and gravel beds that are interbedded with clays and silt. The coarse sediments are more prevalent in the western and southern portions of the subbasin.

The relationship of the older fanglomerate and the Tulare Formation is unclear, based on the drillers' well logs. Previous authors have called the fanglomerate as the Tulare Formation (Hotchkiss, 1971) or grouped the unit as part of the Riverbank, Laguna, and Tulare Formation (Templin, 1984). Either the Tulare Formation rests on the fanglomerate or the fanglomerate is actually part of the Tulare Formation. As shown on Figures 3 and 4, gravels occur both above and below the Corcoran clay next to the foothills. In some locations, the Corcoran clay appears to extend into the fanglomerate. In either case, the gravels are a potential conduit to convey water below the Corcoran clay.

The Tulare Formation, in the central portion of the subbasin, rests on the San Joaquin clay. Figures 2 through 4 show the location of the clay and depths where it was encountered. Although the formation was not fully penetrated, it is at least 400 feet thick.

2.1.2 Geologic Structure

Portions of the Tracy subbasin are bounded on the west by the Black Butte Fault. Movement along the fault appears to have warped the edge of the Corcoran clay upward. North from the fault, the clay appears to flatten and remains at a relatively constant depth below ground surface. Figures 2 through 6 show this relationship.

The Tulare Formation appears to dip toward the west. Near Antioch, the Corcoran clay may be over 600 feet bgs, while near Vernalis the clay is only 200 feet bgs. Figure 2 shows the dip of the Corcoran clay in the east west direction.

2.1.3 Aquifers

Sand and gravel beds are generally grouped together to form aquifers that may display similar characteristics. The aquifers are separated by single or multiple clay layers (or aquitards) that can slow or prevent vertical movement of groundwater between aquifers.

There are two principal aquifers in the subbasin that are separated by the Corcoran clay. The Corcoran clay acts as a regional low permeability layer that limits vertical movement of groundwater. Figures 10 through 15 show the relationship and extent of the aquifers.

Above the Corcoran clay are unconfined to semi-confined aquifers. The groundwater is not compressed and results in a water surface that is at atmospheric pressure or a water table aquifer. These aquifers are roughly 80 to 300 feet thick within the groundwater management plan area. The unconfined and confined aquifers are in the recent alluvium and in the upper portions of the Tulare Formation.

Below the Corcoran clay, the aquifers are confined. In a confined aquifer, the groundwater is under pressure. When a confining bed is penetrated, the water level rises above the bed and could result in artesian flowing wells. These confined aquifers in the subbasin are up to 500 feet thick and are present in the lower portions of the Tulare Formation.

In the western portion of the subbasin, where the fanglomerates may have replaced the Corcoran clay, the unconfined and confined aquifers may be connected. The unconfined and confined aquifers also join outside of the subbasin to the east. The Corcoran clay ends somewhere west of the San Joaquin River, as shown on Figure 8. Figures 11 through 13 show the aquifers merging to the east. The unconfined aquifer recharges the confined aquifer in those areas where the Corcoran clay is absent.

2.1.4 Base of Fresh Water

The entire Tracy subbasin is underlain by saline water. The base of fresh water is the boundary between water of specific conductance greater than or less than 3,000 micromhos per centimeter (µmhos/cm) (a TDS of about 2,000 mg/L). In the Tracy subbasin, the mapped base of fresh water ranges from about 800 feet bgs below the City to depths of 2,000 feet beneath the western part of the City (Page, 1973 and Berkstresser, 1973).

2.1.5 Groundwater Levels

Groundwater levels are typically sorted by aquifer to identify the conditions and flow direction in each aquifer. When wells are constructed with long screen intervals that cross multiple aquifers, the water level is a composite and is not useful to identify groundwater conditions. Wells that are screened in a single aquifer are needed to assess the hydrogeologic conditions.

Groundwater levels have been monitored in the southern portion of the subbasin by DWR and San Joaquin County for many years. DWR monitored over 100 wells up to the mid 1970s when the level of monitoring decreased. Nineteen of these wells were screened in just one aquifer, all within the unconfined aquifer. Currently, DWR only monitors 17 wells of which only four have drillers' well logs that show which aquifers the well monitors. These four wells are screened above and below the Corcoran clay and, therefore, are not useful. The remaining wells do not have any well construction details; therefore, the aquifers being monitored are unknown. The current groundwater level data from DWR monitored wells cannot be used to interpret groundwater levels in the subbasin.

San Joaquin County is monitoring groundwater levels in 15 wells within the study area. Only four of the wells have logs that show the construction details and indicate all have short screen intervals entirely within the unconfined aquifer. These wells can be used to interpret groundwater levels.

There are several other sources that have wells with logs, are measuring groundwater levels, and that are solely within one aquifer. Although they have a shorter historic record, the groundwater level measurements are currently being obtained. The sources include the following:

- The City has eight production wells that are constructed just below the Corcoran clay. They also have an additional 18 monitoring wells that are also located just below the Corcoran clay.

- The Tracy Army Depot (Depot) has several monitoring wells that are constructed above the Corcoran clay. The Depot also has three deep groundwater supply wells that reportedly obtain groundwater from below the Corcoran clay. Well

construction details are not currently available. It is unknown if water levels are currently being measured in these wells.

- DWR is performing geotechnical and seepage investigations around the Clifton Court Forebay and on levees in the Sacramento-San Joaquin River Delta (Delta). Four shallow groundwater monitoring wells were monitored for a short time but provide groundwater levels in the shallow aquifer in the Delta.

- The USGS recently completed a water quality evaluation of the area (USGS, 2006). Eleven groundwater monitoring wells are present within the subbasin. The report does not provide groundwater levels. Also, construction details are limited to the top and bottom of the well screen interval and do not indicate the depths of the annular seals.

- There are several properties that have had releases of contaminants to the environment. Most of these properties have constructed monitoring wells into the unconfined aquifer. However, once the groundwater contamination is resolved, the wells will be destroyed and monitoring will cease.

Tables 1 and 2 present summaries of the wells currently being monitored and their construction details. The tables also identify which aquifer is monitored by each well. Tables 3 and 4 show the groundwater level measurements from these wells.

Groundwater levels in the unconfined aquifer range from about one to 55 feet bgs in the subbasin. Figures 10 through 15 show the depth to water in the unconfined aquifer.

Although there are multiple coarse-grained sediment layers that make up the unconfined aquifer, the water levels are generally similar. Some of the best details are available from the Depot. Their investigative work shows that groundwater levels in the three layers present beneath the Depot have less than 0.03 feet of difference in the groundwater levels (URS personal comm., 2006). Although wells may be constructed to different depths in the unconfined aquifer, the groundwater levels are comparable.

Groundwater levels in the unconfined aquifer show two trends. Figure 16 shows the historic (1952-2003) water level measurements at eight wells in the subbasin. Figure 1 shows the location of these wells. Wells that are located in the central portion of the study area and have groundwater level trends that are generally flat lying, showing the aquifer is full. Based on the aquifer profiles, the groundwater is in hydraulically communication with the San Joaquin and Sacramento Rivers. Wells 2S/4E-28H1 and 2S/4E-35D2, located near the southwestern margin of the basin, show that groundwater levels prior to 1970 were lower and have since recovered by as much as 140 feet. There are no measurements since 1991 to confirm this trend. It appears growers were pumping groundwater in these areas.

Groundwater levels (piezometric heads) in the confined aquifer are about 50 to 150 feet bgs. The groundwater levels are always above the top of the Corcoran clay by about 1,200 to 240 feet. Figures 10 through 15 show the confined aquifers groundwater levels.

Groundwater levels in the confined aquifers fluctuate seasonally with response to pumping and seasonal recharge to the aquifers. Figures 17 and 18 show the trends in two monitoring wells located within the City. Since 2003, groundwater levels have generally risen by about five feet.

Groundwater levels in the confined aquifer show a mixture of downward gradients and upward gradients that range from one to nine feet between each coarse-grained sedimentary layers. There is a consistent downward gradient between the individual aquifers in the southern and western portions of the City, with an upward gradient between the lower two aquifers in the eastern and northern portions of the City. The downward heads may indicate a potential recharge area.

Although groundwater levels vary seasonally within the confined aquifer by as much as 20 feet, groundwater levels in the unconfined aquifer are flat lying and are not showing the seasonal fluctuations. Figures 17 and 18 show a comparison of groundwater levels in the confined and unconfined aquifers. The graphs also show groundwater levels in the unconfined aquifer may at times be greater than the groundwater levels in the unconfined aquifer. Wells with well screens in both the unconfined and confined aquifers in these areas will allow the unconfined aquifer to recharge the confined aquifer. In areas where the confined aquifer has a higher water level than the unconfined aquifer, groundwater wells with screens above and below the Corcoran clay will allow groundwater from the confined aquifer to recharge the unconfined aquifer.

2.1.6 Groundwater Flow Directions

Groundwater contour maps show the direction of groundwater flow, recharge areas, and areas of discharge. The groundwater flow direction is typically 90 degrees to the groundwater contour.

The groundwater flow direction in the unconfined aquifer is northerly, toward the San Joaquin River. Groundwater recharge to the unconfined aquifer is from the Coast Ranges, possibly from Corral Hollow Creek or Hospital Creek. Groundwater may be discharging to the San Joaquin River. Figure 19 shows groundwater contours developed for the unconfined aquifer for spring 2005. The groundwater measurements used to generate the contours are not from a single date but were obtained over a four-month period and likely affect the interpretation. Table 3 lists the dates when the measurements were obtained.

Groundwater contours for the confined aquifer are limited to those measurements that have been made near the City. The City monitors groundwater levels in three different sedimentary layers (Zone A, B, and C from shallowest to deepest, respectively) starting at a

depth of about 400 feet to 800 feet bgs. Groundwater contours are presented for spring 2005, but do not change seasonally.

The groundwater contours (piezometric heads) for the confined aquifer (Zone A clustered monitoring wells) represent groundwater movement in a coarse-grained layer immediately beneath the Corcoran clay. The contours show that this aquifer receives recharge from the southwest and northeast. In comparison to the Zone A aquifer, the intermediate aquifer (Zone B monitoring wells) is more influenced by sources east of Tracy. Groundwater contours for the deep aquifer (Zone C monitoring wells) are similar to the intermediate aquifer (Zone B), but with recharge to the aquifer from the east and little to no recharge from the southwest.

Figure 20 shows the confined aquifer groundwater contours (piezometric heads) for October 2005, based on water level measurements from the City's production wells perforated below the E-clay and supplemented with measurements from the shallow aquifer (Zone A) clustered monitoring wells. The contours show groundwater is moving in a radial pattern from the south, east, west, and north toward pumping depressions beneath central portions of the City. The gradient is steeper on the north side of the depression, suggesting the presence of lower permeability aquifers or a recharge source.

Another pumping depression is centered over Production Well 1 near the Tracy airport. This pumping depression has been present since monitoring began, but the size of the depression is poorly constrained (few or no monitoring wells south, west, or east of the well field).

2.1.7 Hydraulic Characteristics

The hydraulic characteristics of sediments and aquifers are data that provide the foundation for predicting the effects of management options before their implementation. They are basic scientific parameters used to estimate and predict the speed and direction of groundwater movement, groundwater storage, and the potential effects of groundwater pumping on groundwater levels and other wells. These characteristics can be used to answer a number of questions: how should wells be spaced to avoid conflicts; how will the aquifers react to a reduction in recharge resulting from conservation measures; how much water should be removed (in areas with high groundwater table) to lower water levels to benefit agriculture; how much water will a well produce; and how will water quality be affected by the mixing of water from different sources?

The hydraulic characteristics of sediments and aquifers use several terms to quantify the ability to store and transmit water. The *hydraulic conductivity* is the ability of the sediments to transmit water in sediments. *Transmissivity*, a term applied to aquifers, is the hydraulic conductivity multiplied by the thickness of the sediments capable of storing water. All sediments have some void space between the particles; this void space is reported as *porosity*. Water in the void spaces cannot be entirely removed. The *storage coefficient* is the percentage of water that can be removed from the pores by gravity drainage and is applied

when describing unconfined aquifers. *Storativity* is similar to storage coefficient, but is the percentage of water that can be released from the pores by a decrease in pressure. Storativity is used when referring to semi-confined or confined aquifers.

The hydraulic characteristics of the unconfined aquifer are highly variable. Wells in the unconfined aquifer produce 6 to 5,300 gallons per minute (gpm) (well 2S/6E 24). Pumping test data are limited. The transmissivity of the unconfined aquifers, including the recent alluvium and upper portions of the Tulare Formation, ranges between 600 to greater than 2,300 gallons per day per foot (gpd/ft). The storativity is estimated to be about 0.05 based on descriptions of the sediments. Where thicker sequences of sand are present, the transmissivity may be higher.

The hydraulic characteristics of the confined aquifer are typically higher than the unconfined aquifer. Wells typically produce about 700 to 2,500 gpm. The transmissivity ranges from about 12,000 to 37,000 gpd/ft and may range up to 120,000 gpd/ft where large sequences of gravel are present. The storage coefficient or storativity is obtained through aquifer tests such as the testing that has occurred at Production Well 8. The storativity is about 0.0001 (Padre, personal communication, 2004).

The hydraulic characteristics of the fanglomerate is unknown but may be relatively low. One well that was Well 4S/6E-5 as shown on Figure 3, has a yield of 62.5 gpm, which is quite low and may be an indicator of low transmissivity sediments. No additional information about the pumping information is available to fully assess the hydraulic characteristics.

The Corcoran clay is a regional layer that restricts movement between the unconfined and confined aquifers. Because the clay is permeable to some degree, water can migrate vertically through the layer but typically at very slow rates. Although this migration rate is very slow, the amount of water moving through the clay can be significant given the large area covered by the clay and head differences across the clay. No test data are available for the Corcoran clay, but some groundwater models have “backed into” what appear to be reasonable permeability values. The vertical permeability estimated ranged from 0.01 to 0.007 feet per day (Burow et al. 2004). The Corcoran clay’s ability to act as a regional aquitard is uncertain because of the large number of wells. The gravel pack surrounding the wells and the wells themselves act to connect the unconfined aquifer with the confined aquifer (Page and Balding 1973).

2.2 Groundwater Quality

Groundwater quality data for the unconfined aquifer is limited to a basin-wide study of the unconfined aquifer in 1968 and more recently from multiple sources, mostly environmental studies that provide information for both the unconfined and confined aquifers. Most of the environmental studies have collected just electrical conductivities that were converted to an estimate of total dissolved solids (TDS) to make the data comparable to the 1968 data. The

1968 water quality information is used to identify constituents of concern, while electrical conductivity and TDS measurements for 2005 were used to characterize the current water quality in the unconfined aquifer. Water quality data in the confined aquifer are regionally limited to just those monitoring wells constructed near the City. The City's data are of high quality and can be used to evaluate constituents of concern for the confined aquifer. Tables 5 and 6 list the water quality data used. Groundwater contours from 2005 are shown to portray the groundwater flow direction and the potential source of the good and poor quality water.

Groundwater in the Tracy subbasin is variable with some localized areas of good quality water. For the most part, good quality water is present in both the confined and unconfined aquifers near the southwestern margin of the subbasin. In the remaining portions of the subbasin, the groundwater is marginal to poor and could move into the areas of good quality water. Problem constituents (constituents of concern) include TDS, nitrates, boron, chloride and sulfate. In addition to these constituents, localized areas of man-made contamination including trihalomethanes, volatile organic compounds (solvents), and gasoline are present. The following sections discuss these problem constituents, contamination, and their relationship to the aquifers and sediments.

2.2.1 Total Dissolved Solids

TDS is a measure of the amount of salts in the water (typically measured by evaporating the water and weighing the remaining salts). Electrical conductivity (EC) is also a measure of the salts in the water but uses the water's ability to pass an electric current. The TDS of water can be approximated by multiplying the EC by 0.55 to 0.70 (Hem, 1989).

Salts are a concern for both potable and agricultural users. Salt-tolerance (TDS) thresholds for permanent and vegetable crops may be as low as 600 milligrams per liter (mg/L). Drinking water standards provide recommended maximum contaminant levels (MCLs) of 500 mg/L. An upper limit of 1,000 mg/L is allowed if it is not reasonable or feasible to supply water with lower concentrations. Short-term use is allowed for water between 1,000 and 1,500 mg/L.

The TDS concentrations in the unconfined aquifer (1968 data) range between 569 and 2,754 mg/L. Figure 21 shows the TDS distribution in 1968 for the area with available information. The plot shows the best water quality is located along the southwestern margin of the subbasin. The TDS concentrations increase toward the San Joaquin River and to the northwest.

TDS concentrations for the unconfined aquifer in 2005 were not available for the same wells sampled in 1968. Most of the currently available data were from environmental sites, which typically are sampling the upper portions of the unconfined aquifer. In most cases, samples were not collected for TDS, but electrical conductivity measurements were available. Electrical conductivity values were converted to TDS to allow a comparison to the 1968 results. Table 5 shows which wells have calculated estimated TDS values. Figures 22 shows

the TDS concentration obtained in 2005 for the unconfined aquifer. The results show a similar pattern to the 1968 data, with better quality water along the southwestern margin of the subbasin. The groundwater flow direction for 2005 shows the groundwater is flowing from the southern portion of the subbasin northward toward the Delta. The groundwater flow direction, in combination with the source of the high quality water, suggests groundwater is recharging the unconfined aquifer from the southwestern margin of the valley. Corral Hollow and Hospital Creek, along with potential leakance from the Delta-Mendota Canal and Central Valley Project canals, are potential sources of low TDS recharge to the unconfined aquifer.

TDS concentrations for the confined aquifer are limited to production wells with long screens owned by the City and short screen monitoring wells owned by the City. The area with water quality data for the confined aquifer is much smaller than the area of known water quality in the unconfined aquifer and is very small in respect to the subbasin investigation area. The monitoring wells, which have short screens in the three aquifers (Zones A through C) below the Corcoran clay, were used to develop TDS concentration plots for 2005, which are shown on Figure 23. The TDS concentrations in aquifers below the Corcoran clay range from 300 to 1,070 mg/L. The best quality water is from sediments immediately below the Corcoran clay. Generally, the water quality degrades with depth. The poorest quality water occurs at monitoring well 5C (screened from 770-810 feet bgs), which is located in the northeastern portion of the City and has a TDS of 1,070 mg/L. The plots show that better quality water is present along the southwestern side of the subbasin and generally has a poorer quality to the north and east. This area of good quality water in the confined aquifer coincides with good quality water in the unconfined aquifer. These occurrences suggest the water from the unconfined aquifer may be recharging the confined aquifer along the southwestern edge of the basin.

2.2.2 Sulfate

The recommended drinking water standards for sulfate (which is a component of TDS) is 250 mg/L with an upper limit of 500 mg/L and for short-term use is 600 mg/L. Use of water above the recommended MCL is allowable if it is not reasonable or feasible to supply water with levels less than 250 mg/L.

Sulfate concentrations in the unconfined aquifer, based on 1968 data, show a similar distribution as TDS. Figure 24 shows the sulfate distribution. The concentrations are the lowest near the airport and increase toward the north and east. The concentrations range from less than 100 to over 600 mg/L. There are no current analyses available to show the distribution of sulfate in the unconfined aquifer during 2005.

In the confined aquifer, sulfate varies with depth. Isolation aquifer zone testing during test hole drilling at the City's Production Well 5 developed a profile of the water quality with depth. The lowest sulfate concentration, 93 mg/L, was found in the Zones A and B aquifers.

Relatively low sulfate concentrations, 132 to 137 mg/L, were also found in the Zone C aquifers at depths of 828 to 998 feet. Below 828 feet, the sulfate concentration increased to a range of 162 to 181 mg/L.

Groundwater quality data for the confined aquifer show low concentrations of sulfate occur in the Zone A aquifer near and west of the airport. Figure 25 shows the distribution. Higher concentrations are present to the east. Higher concentrations are present in Zones B and C aquifers. The lowest concentrations continue to occur near the airport in Zone B but increase in Zone C, confirming the general increase in concentrations with depth as observed by the isolation zone testing.

Although most of the monitoring wells are showing concentrations of sulfate in the confined aquifer are below the MCL, production wells operated by the City commonly have sulfate that exceeds the MCL. This suggests the sulfate is not coming horizontally through the aquifers but may be from either the unconfined aquifers or from upwelling of groundwater from lower aquifers.

2.2.3 Chloride

The recommended drinking water standards for chloride (which is a component of TDS) is 250 mg/L with an upper limit of 500 mg/L and for short-term use is 600 mg/L. Use of water above the recommended MCL is allowable if it is not reasonable or feasible to supply water with levels less than 250 mg/L.

Chloride concentrations in the unconfined aquifer in 1968 range from 71 to 903 mg/L, with lowest concentrations near the Coast Ranges south of Tracy (see Figure 26). The highest concentrations occur to the east and west. There are no current analyses available to show the distribution of chloride in the unconfined aquifer during 2005.

Groundwater quality data for the confined aquifer show low concentrations of chloride (57 to 130 mg/L) occur throughout Zones A and B aquifers, significantly lower than the unconfined aquifer. The lowest concentrations are in the western portions of the City. Higher concentrations are present in Zone C aquifers, ranging from about 100 to over 500 mg/L. The highest concentrations are at monitoring well MW-5C and correspond to the highest TDS value shown on Figure 27.

A water quality investigation has been performed in the Stockton area to assess the reason for high concentrations (greater than 250 mg/L) of chloride (Izbicki, 2006). The investigation used both major and minor ions and oxygen and hydrogen isotopes to assess the sources of the chloride. Preliminary results have found four potential sources for the high chloride concentrations: (1) evaporation of irrigation water, (2) Delta surface water, (3) entrainment of seawater may have occurred during deposition of the sediments, and (4) water from marine rocks and oil-field brines. High chloride water found in shallow portions of the aquifer is related to Delta water. Isotope results showed some of the shallower wells suggest

chloride increases were related to evaporation of irrigation water. Some wells showed the high chloride water was related to seawater that has been minimally altered by contact with aquifer materials. Water from most wells, collected from the deeper parts of the aquifer, showed iodide enrichment similar to that of water from marine rocks and in oil field brines. This is somewhat unusual because marine rocks are not present, at least not in the Tracy area, to depths of greater than 3,400 feet bgs.

Exploration for natural gas has occurred throughout the Tracy subbasin. Wells drilled for gas production penetrated into the underlying marine sediments. Water and sediments typically contain high concentrations of salt, chloride, and other heavy metals. Residues from the drilling operations and/or improperly sealed or destroyed wells may degrade the natural water quality. Gas traps were found that trend across the subbasin from southeast to the northwest. Figure 28 shows the gas well locations in comparison to chloride concentrations. The highest concentrations of chloride in the confined aquifer are found at a depth of about 800 feet near the Tracy gas field. It is likely the chloride is either from an improperly abandoned or destroyed gas exploration hole or well or a natural break in the sediments, which allows water to migrate upward.

2.2.4 Nitrate

Nitrate is an essential element for plant growth. However, some permanent crops, including grapes, may be adversely affected by excess nitrate. High nitrate levels are also detrimental to human health. Drinking water standards establish an MCL of 45 mg/L nitrate (as nitrate) or 10 mg/L when nitrate is reported as nitrogen.

Nitrate (as nitrogen) in the unconfined aquifer in 1968 has lower concentrations in the eastern portion of the subbasin with the highest concentrations in the western portion of the subbasin. One well near the airport, where orchards are present, has relatively high concentrations. It is unknown if this is a point source or a regional pattern. Figure 29 shows the distribution of nitrate in 1968. There are no current analyses available to show the distribution of nitrate in the unconfined aquifer during 2005.

Nitrate (as nitrogen) concentrations in the confined aquifer are lower than in the unconfined aquifer and well below the MCL for drinking water (see Figure 30). Nitrate in the coarse-grained sediments immediately below the Corcoran clay in the Zone A aquifer are at non-detectable concentrations, less than 0.25 mg/L. In comparison to the unconfined aquifer, this suggests the Corcoran clay is an effective barrier to vertical groundwater flow. Low concentrations (less than 1.9 mg/L) of nitrate are present in Zones B and C aquifers. These locations suggest the nitrate is either (1) naturally occurring, (2) migrating into the aquifers from the west, or (3) migrating vertically into the confined aquifers through idle wells with multiple well screens that are located in both the unconfined and confined aquifers.

2.2.5 Boron

Excessive amounts of boron in groundwater may result from several sources. Groundwater in volcanic areas and water of many thermal springs contain elevated concentrations of boron. Boron may be liberated from, or contained in, volcanic gases. Marine sediments may also contain boron either as a residual from contact with ocean water or as connate water. Ocean water has about 4.6 mg/L of boron. Boron is also widely used as a cleaning aid and may be present in sewage and industrial wastes. Boron can negatively affect some plants such as fruit trees, grapes, and nuts at levels of about 1 mg/L (Hem, 1989).

Boron concentrations in the unconfined aquifer, based on the 1968 data, ranges from 0.7 to 6.3 mg/L. Figure 31 shows the boron distribution. The lowest concentrations again follow a similar pattern as the TDS, with low concentrations next to the Coastal Range foothills. No boron data were available for the unconfined aquifer in 2005.

Boron concentrations in the confined aquifer are generally between 0.8 and 1.9 mg/L as shown on Figure 32. The lowest concentrations, for the most part below 1.0 mg/L, are in the Zone A aquifer in the southern and western portions of the subarea. In Zones B and C, the concentrations are relatively uniform, but for the most part, all above 1.0 mg/L. The lowest occurrences in Zones B and C are in the southern portion of the subbasin. Therefore, it appears the higher concentrations are related to either (1) the mobilization of boron from the sediments, (2) marine water trapped in the sediments, or (3) horizontal groundwater inflow into the aquifers.

2.2.6 Volatile Organic Chemicals (VOCs)

VOCs are present in the groundwater in the subbasin as a result of industrial activities. VOCs detected in the groundwater included trichlorofluoromethane (TCFM), 1,1,1-trichloroethane, and 1,1 dichloroethene (1,1-DCE), trichloroethylene (TCE), and carbon tetrachloride. Along with these major chemicals are their daughter products, those that have decayed to other compounds. Several of these chemicals have been detected at concentrations above the drinking water MCLs. A complete search for properties with releases of VOCs has not been performed but a few of the releases to the environment occurred at the Tracy Army Depot, Pioneer, and the Former Georgia-Pacific Corporation Tracy Chemical Packaging Plant.

Petroleum fuel products have leaked from underground storage tanks at multiple locations throughout the subbasin. Contaminants present from gasoline fuels include toluene, benzene, ethylbenzene, xylenes and methal tertiary-butyl either (MTBE). Other than for MTBE, the other contaminants will naturally degrade within several hundred feet of the leak, once the contamination source has been removed. However, MTBE does not naturally degrade and typically moves at the same speed as the groundwater.

All the contamination is in the unconfined aquifer. Groundwater management activities need to account for, and assist in limiting, the migration of the chemicals from these properties.

2.2.7 Constituents of Concern

In summary, each of the aquifer systems has water quality problems as listed below. For the most part, these problems affect only portions of the subbasin. In general, constituents of concern in the subbasin are:

- Unconfined Aquifer – TDS, chloride, nitrate, boron, and VOCs
- Confined Aquifer – TDS, chloride, sulfate, and boron

Both chloride and sulfate are related to the occurrence of TDS. Management actions to improve one of these problems will likely resolve multiple constituents.

2.2.8 Groundwater Quality Trends

There is limited duration water quality available to interpret the long-term water quality trends in the subbasin. Because of the potential for chloride and TDS concentrations to affect water quality near Monitoring Well 5, trend plots were developed for the three-year period since it was constructed. Figure 33 shows TDS and chloride concentrations. TDS shows a potential slight increase, while chloride shows a flat trend. Figure 34 shows the TDS and chloride trends for the Lincoln Well, which is near MW-5, and for Production Well #1, which is located near the airport. The chloride concentrations at the Lincoln well show chloride is trending upward while at Production Well #1, chloride has a flat trend. Similar trend plots should be developed for the unconfined aquifer when data become available.

2.2.9 Groundwater Recharge and Discharge Areas

Groundwater recharge in the unconfined aquifer occurs from precipitation, applied water, and seasonally from infiltration by the creeks. The recharge for the shallow unconfined aquifer is generally from the south, from the Coast Ranges, and moves to the north and west. Pumping within the unconfined aquifer can move water from the Delta and the San Joaquin and Sacramento Rivers into the aquifers as they are in direct communication with these surface water bodies as shown on Figure 7.

Recharge to the confined aquifer is from the unconfined aquifer where the Corcoran clay is absent adjacent to the Coastal Range foothills. Groundwater recharge to the confined aquifers is also from the east side of the San Joaquin River where the Corcoran clay is absent.

Locally, groundwater may move between the unconfined and confined aquifers through improperly constructed water supply wells that have perforations within both the unconfined and confined aquifers. The gravel packs that surround the wells can also convey water vertically. Dependent upon the level of the groundwater surface or the piezometric head, the

unconfined aquifer can recharge the confined aquifer or vise versa. In the fan area south of the City, the confined aquifer will recharge the unconfined aquifer where, within and north and east of the City, the unconfined aquifer will recharge the confined aquifer.

3 Summary

The Tracy subbasin is bounded to the south by non-water-bearing bedrock consisting of old marine sediments. Water-bearing sediments within the subbasin consist of recent alluvium, Tulare Formation, and an older fanglomerate. The alluvium covers most of the subbasin and ranges in thickness from a few feet near the foothills to about 300 feet near Antioch. In the central and western portion of the subbasin, the recent alluvium is the thickest and contains multiple nested sand beds that were deposited by the Sacramento and San Joaquin Rivers. The sand layers decrease toward the margins of the basin. The recent alluvium is underlain by the Tulare Formation and fanglomerate. The Tulare Formation is subdivided into an upper and lower unit, both containing layers of sand and gravel interbedded in relatively thick sections of clay and silt. The formation is divided by the Corcoran clay, which is a regional clay bed that limits vertical flow of groundwater. The edge of the clay is about 300 feet bgs just west of the San Joaquin River and the clay dips to the west to a depth of about 600 feet near Belmont. Along the southern margin of the subbasin are fanglomerates. Because the fanglomerates are older, the Tulare Formation should have been deposited onto the deposits and, therefore, the Corcoran clay should be absent. Well logs suggest the Corcoran clay extends into the fanglomerates, which suggests the fanglomerates may be part of the Tulare Formation. Adjacent to the foothills, the Corcoran clay may be interfingered with the fanglomerate or the clay may be entirely absent. Although there are insufficient data to resolve the relationship, the fanglomerates potentially allow groundwater recharge to the sediments below the Corcoran clay.

The subbasin contains two aquifers that are composed of multiple thin sand and gravel beds. An unconfined to semi-confined aquifer is present above the Corcoran clay. The aquifer is present in the recent alluvium and the upper portions of the Tulare Formation. The confined aquifer is present below the Corcoran clay to a depth of about 800 feet bgs. The unconfined and confined aquifers merge where the Corcoran clay is absent, near the southern portion of the subbasin adjacent to the foothills and just east of the San Joaquin River.

Groundwater levels show the unconfined aquifer is essentially full because groundwater levels are remaining within a narrow range. Groundwater levels rose in two of the wells near the foothills either as a result of discontinued pumping or because of a new recharge source. High groundwater is present in portions of the subbasin and may affect infrastructure. Groundwater levels in the confined aquifer show there are relatively small pumping depressions. The groundwater trend over the last few years shows the levels to be increasing. There is about 40 feet of additional storage in the confined aquifer.

The geologic materials, water quality, and groundwater contours show groundwater recharge to the unconfined aquifers occurs from precipitation, deep percolation of imported irrigation

water, and recharge from creeks from the Coastal Ranges. Pumping in the unconfined aquifers could induce groundwater recharge from the Sacramento and San Joaquin Rivers. Groundwater recharge to the confined aquifer occurs in the foothills adjacent to the Coast Ranges through the fanglomerate, from the east side of the San Joaquin River, and in some areas through wells that are screened in both the unconfined and confined aquifers.

The groundwater quality is highly variable in the subbasin. Although recent information is limited, preliminary interpretations suggest that some of the best water quality in both the unconfined and confined aquifers occurs in the southwestern portion of the subbasin where apparent groundwater recharge from creeks from the Coastal Ranges and possibly leakance from the Delta-Mendota and the Central Valley Project canals. In the unconfined aquifer, most water quality parameters, except for nitrate, show lobs of good quality water emitting from the area near Corral Hollow Creek with concentrations increasing toward the north and west to the point where the direct use of the groundwater is not possible due to health concerns. Nitrate does not show this same pattern and suggests that local land use practices may be affecting the water quality. The confined aquifer is showing similar lobs of good quality water emitting from the area near Corral Hollow and moving toward the north. The lobs are distinct to depths of about 600 feet bgs and thereafter start to be less prominent. This suggests the coarse-grained fanglomerates are hydraulically connected to sediments to at least these depths. The water quality changes distinctly near the eastern edge of the City, where high concentrations of chloride and TDS are present at a depth of about 800 feet bgs.

Preliminary results have found four potential sources for the high chloride and TDS concentrations: (1) evaporation of irrigation water, (2) Delta surface water, (3) entrainment of seawater in Delta deposits which may have occurred during deposition of the sediments, and (4) water from marine rocks and oil-field brines. The coincident of the high chloride water in the northeastern portion of the City with the gas well fields suggests there may be a relationship. The cause could be natural imperfections in the sediments that allow water to migrate vertically from underlying marine sediments or improperly sealed or destroyed gas wells. The source of the high nitrate groundwater appears to be related to deep percolation of agricultural return water. The high concentrations of boron could be related to entrainment of seawater in the recent alluvium or from the groundwater being in contact with sediments that were derived from a volcanic source. High concentrations of sulfate appear both above and below the Corcoran clay. The source of the sulfate appears to be naturally occurring. It appears to increase with depth, and higher concentrations appear where pumping may be upwelling water from deeper aquifers.

Part of the water quality problem within the confined aquifer is the ability to move water through the aquifers. Because the Corcoran clay increases with depth to the west, it does not appear that there is natural exposure of the confined aquifer that would allow water to flow through the aquifer, allowing good quality water from the Sierra Nevada Mountains to replace the groundwater present at the time of deposition of the sediments. Groundwater

extraction in excess of natural recharge could cause this poorer quality water to migrate to the east and into urbanized areas that are relying on groundwater.

Locally, within the unconfined aquifer there are small sources of man-made groundwater contamination. Development of any groundwater management actions must limit changes to the groundwater conditions near these sites to allow the owners to effectively remediate the contaminants.

Overall, the Tracy groundwater subbasin is full but has groundwater quality issues. Groundwater management should focus on creating available storage and managing pumping to increase the amount of good quality water in the subbasin.

Based on the conceptual understanding of the geology and aquifers, we recommend that the following actions be undertaken to secure a more complete understanding of the hydrogeology. Substantial improvements must be made to the groundwater monitoring network to validate the data and assumptions contained herein.

Issue	Action
▪ There is insufficient groundwater level data and quality data are lacking for the unconfined aquifer.	▪ Obtain more active involvement from San Joaquin County who oversees several groundwater supply wells in the area. Discuss with DWR reactivating monitoring at wells where well logs are available. Construct additional monitoring wells as necessary to define the extent and track the movement of poor quality water from the west, north, and east (see Tables 7 and 8).
▪ There is insufficient groundwater level data and water quality data are lacking for the confined aquifer.	▪ Since there are no additional existing wells constructed solely in the confined aquifer, construct dedicated multi-level monitoring wells. The wells will be used to assess the extent of the Corcoran clay, confirm groundwater recharge areas, the depth of the high sulfate water, and to protect the confined aquifer water quality from movement of high TDS and chloride water.
▪ Construction of groundwater wells can degrade water quality in the confined aquifer.	▪ Develop maps showing the top and bottom and extent of the Corcoran clay to assure that sanitary and annular seals are placed through the bottom of the clay to make implementation of existing ordinances more effective and protective of the water quality in the confined aquifer.

Issue	Action
▪ Identify existing water supply wells that are screened in both the unconfined and confined aquifers and approach owners to modify or destroy the wells.	▪ Apply for state funding to assist well owners with well modifications.
▪ Municipal water quality is exceeding MCLs for TDS and sulfate. Production wells in the confined aquifer appear to creating upwelling of groundwater from deeper aquifers that contain high concentrations of sulfate.	▪ Perform spinner surveys and discrete water quality sampling in City of Tracy production wells. Use existing monitoring wells at Production Well 5 to further assess the depth variability of TDS and sulfate. If necessary, plug the lower portions of the wells to improve water quality.
▪ Groundwater flow directions are poorly defined and, therefore, interpretations of recharge and discharge areas and of the interactions between aquifers may change greatly.	▪ Implement the Groundwater Monitoring Plan. A hydrogeologist should interpret the data and prepare groundwater contour maps. Identify uncertainties, refine the monitoring network, and propose resolutions to improve the interpretations. Prepare an annual state of the basin report so all stakeholders can participate.
▪ The unconfined and confined aquifers have areas of poor quality water.	▪ Once the monitoring well network is constructed optimize pumping to enhance the movement of good quality water into the aquifers and create a pool of good quality water that can be relied upon during droughts.
▪ Water quality in the confined aquifer is partially dependent upon activities east of the San Joaquin River.	▪ Participate in the Northeast San Joaquin County Groundwater Banking Authority.

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Tables

TABLE 1
UNCONFINED AQUIFER MONITORING WELLS CONSTRUCTION DETAILS

Well ID	Owner	Reference Point Elevation (Feet MSL)	Total Depth (Feet bgs)	Screen Interval (Feet bgs)
LMO65C	**Tracy Army Depot**	64*	166.0	144-160
LM124C	**Tracy Army Depot**	112*	150.0	147-157
LMO47C	**Tracy Army Depot**	78*	144.0	123-134
02S4E09A001M	**San Joaquin County**	47	110	80-100
02S05E13N001M	**San Joaquin County**	24	172	115-135
				44-168
01S05E35Q002M	**San Joaquin County**	8	305	225-245
03S06E03F002M	**San Joaquin County**	29	138	118-135
MW1 **	**Dick's Exxon**	28.37	19.68	NA
MW-2 **	**7-11 #32262**	25.32	17	7-17
MW-4B **	**Pombo Ranch**	53.55	20.40	NA
MW-1 **	**Deuel Vocational Institute**	14.32	NA	NA
MW-101 **	**George's Service**	85.84	37.58	NA
MW-5 **	**Sinclair Trucking**	75.88	20.01	85
MW-2 **	**Joe's Truck Plaza**	13.68	20	NA
MW-8 **	**Joe's Truck Plaza**	14.55	40	23-38
WELL BW-3	**Spreckles Sugar**	4.59	90.30	NA
WELL BW-4	**Spreckles Sugar**	10.12	102.10	NA
WELL WP-7	**Spreckles Sugar**	16.64	99.73	NA
Well BC-19	**Georgia-Pacific**	98.78	NA	NA
Well BC-20	**Georgia-Pacific**	89.53	NA	NA
Well MW-23	**Georgia-Pacific**	102.24	NA	NA

NA= Not Available
*Approximated values
** Geotracker wells.
Geotracker Website: http://geotracker.swrcb.ca.gov/search/casesearch.htm
Insert site case number at Geotracker website for current site information.

Well ID	Site	Case Number
MW1 **	Dick's Exxon	390629
MW-2 **	7-11 #32262	391147
MW-4B **	Pombo Ranch	391027
MW-1 **	Deuel Vocational Institute	390037
MW-101 **	George's Service	390375
MW-5 **	Sinclair Trucking	390133
MW-2 **	Joe's Truck Plaza	231585
MW-8 **	Joe's Truck Plaza	231585

TABLE 2
CONFINED AQUIFER MONITORING WELLS CONSTRUCTION DETAILS

Well ID	Owner	Reference Point Elevation (Feet MSL)	Annular Seal (Feet)	Filter Pack Interval (Feet)	Screen Interval (Feet)
MW-1B	**City of Tracy**	50.09	0-590	590-670	618-658
MW-1C	**City of Tracy**	51.20	0-720	720-800	748-788
MW-2A	**City of Tracy**	92.59	0-400	400-480	426-466
MW-2B	**City of Tracy**	92.53	0-614	614-690	634-674
MW-2C	**City of Tracy**	92.53	0-760	760-820	770-810
MW-3A	**City of Tracy**	137.86	0-370	370-415	382-402
MW-3B	**City of Tracy**	138.08	0-530	530-595	540-580
MW-3C	**City of Tracy**	138.22	0-726	726-820	770-810
MW-4A	**City of Tracy**	104.08	0-440	440-505	450-490
MW-4B	**City of Tracy**	102.75	0-660	660-715	680-700
MW-4C	**City of Tracy**	103.11	0-760	760-820	770-810
MW-5A	**City of Tracy**	48.39	0-390	390-460	406-446
MW-5B	**City of Tracy**	47.82	0-560	560-640	576-616
MW-5C	**City of Tracy**	48.06	0-750	750-820	770-810
MW-6A	**City of Tracy**	26.52	0-400	410-450	400-465
MW-6B	**City of Tracy**	26.65	0-560	560-645	590-630
MW-6C	**City of Tracy**	26.79	0-730	755-810	755-795
Lincoln	**City of Tracy**	44.58	0-250	250-980	490-980
Production Well No. 1	**City of Tracy**	202.25	0-300	300-980	450-550
					580-980
Production Well No. 2	**City of Tracy**	202.67	0-250	250-850	420-850
Production Well No. 3	**City of Tracy**	215.6	0-250	250-890	420-890
Production Well No. 4	**City of Tracy**	202.08	0-250	250-940	380-940
Production Well No. 5	**City of Tracy**	49	0-305	305-990	410-480
(Lewis Manor)			0-500		601-630
			690-700		650-670
			580-870		805-830
					900-930
					965-990
Production Well No. 6	**City of Tracy**	27	0-500	500-690	550-598
(Park and Ride)			690-700	700-850	610-636
			580-870	870-1216	656-678
					738-754
					774-796
					966-982
					1014-1122
					1176-1196
Production Well No. 7	**City of Tracy**	22	0-490	490-750	550-598
(Ball Park)			750-770	770-914	570-732
					850-874
Production Well No. 8	**City of Tracy**	Unkown	0-340	340-850	370-460
(ASR)					510-640
					680-820

TABLE 3
RECENT GROUNDWATER LEVELS IN THE UNCONFINED AQUIFER

Well ID	Owner	Reference Point Elevation (Feet MSL)	Date Measured	Depth to Water (Feet)	Water Surface Elevation (Feet)
LMO65C	**Tracy Army Depot**	62.33	3/9/2005	13.49	48.84
LM124C	**Tracy Army Depot**	92.6	3/9/2005	46.3	46.3
LMO47C	**Tracy Army Depot**	73.76	3/9/2005	19.31	54.45
02S4E09A001M	**San Joaquin County**	47	3/5/2002	13.3	33.7
02S05E13N001M	**San Joaquin County**	25.7	10/25/2005	12.5	13.2
01S05E35Q002M	**San Joaquin County**	8			
03S06E03F002M	**San Joaquin County**	31.5	10/25/2005	15	16.5
MW-1	**Dick's Exxon**	28.37	7/7/2006	13.95	14.42
MW-2	**7-11 #32262**	25.32	5/9/2005	8.73	16.59
MW-4B	**Pombo Ranch**	53.55	5/10/2005	11.95	
MW-1	**Deuel Vocational Institute**	14.32	3/9/2005	1.62	12.7
MW-101	**George's Service**	85.84	4/1/2005	12.67	73.17
MW-5	**Sinclair Trucking**	75.88	4/11/2005	11.05	64.83
MW-2	**Joe's Truck Plaza**	13.68	3/9/2005	7.24	6.44
MW-8	**Joe's Truck Plaza**	14.55	9/8/2005	9.86	4.69
MRL-2W	**DWR**	9.1	5/9/2005	8.2	-8.2
GLWL-1W	**DWR**	4.4	5/9/2005	2.3	-2.5
WELL BW-3	**Spreckles Sugar**	4.59	5/11/2005	4.04	0.55
WELL BW-4	**Spreckles Sugar**	10.12	5/11/2005	5.60	4.52
WELL WP-7	**Spreckles Sugar**	16.64	5/11/2005	13.1	3.54
Well BC-19	**Georgia-Pacific**	98.78	3/15/2005	45.18	53.60
Well BC-20	**Georgia-Pacific**	89.53	3/15/2005	37.70	51.83
Well MW-23	**Georgia-Pacific**	102.24	5/18/2005	47.34	54.9

TABLE 4
GROUNDWATER LEVELS IN THE CONFINED AQUIFER

Well ID	Owner	Reference Point Elevation (Feet MSL)	Date Measured	Depth to Water (Feet bgs)	Water Surface Elevation (Feet MSL)
MW-1A	**City of Tracy**	41.47	4/22/2005	66.359	-24.89
MW-1B	**City of Tracy**	41.45	4/22/2005	77.53	-36.08
MW-1C	**City of Tracy**	41.45	4/22/2005	78.52	-37.07
MW-2A	**City of Tracy**	92.59	4/22/2005	122.92	-30.33
MW-2B	**City of Tracy**	92.53	4/22/2005	126.93	-34.41
MW-2C	**City of Tracy**	92.53	4/22/2005	126.76	-34.23
MW-3A	**City of Tracy**	137.86	4/22/2005	168.48	-30.62
MW-3B	**City of Tracy**	138.08	4/22/2005	172.68	-34.60
MW-3C	**City of Tracy**	138.22	4/22/2005	173.54	-35.32
MW-4A	**City of Tracy**	104.08	4/22/2005	130.75	-26.67
MW-4B	**City of Tracy**	102.75	4/22/2005	135.97	-33.22
MW-4C	**City of Tracy**	103.11	4/22/2005	135.35	-32.24
MW-5A	**City of Tracy**	48.39	4/22/2005	71.71	-23.32
MW-5B	**City of Tracy**	47.82	4/22/2005	74.98	-27.16
MW-5C	**City of Tracy**	48.06	4/22/2005	73.48	-25.42
MW-6A	**City of Tracy**	26.52	4/22/2005	50.64	-24.12
MW-6B	**City of Tracy**	26.65	4/22/2005	62.09	-35.44
MW-6C	**City of Tracy**	26.79	4/22/2005	58.01	-31.22
Lincoln	**City of Tracy**	44.58	4/22/2005	84.8	-40.22
Production Well No. 1	**City of Tracy**	202.25	4/22/2005	243	-40.75
				40.75	-40.75
Production Well No. 2	**City of Tracy**	202.67	4/22/2005	243.42	-40.75
Production Well No. 3	**City of Tracy**	215.6	4/22/2005	249.34	-33.74
Production Well No. 4	**City of Tracy**	202.08	4/22/2005	240.59	-38.51
Production Well No. 5	**City of Tracy**	49	4/22/2005	83	-34
(Lewis Manor)				0	0
Production Well No. 6	**City of Tracy**	27	4/22/2005	74	-47
(Park and Ride)				0	0
Production Well No. 7	**City of Tracy**	22	4/22/2005	76	-54
(Ball Park)				0	0
Production Well No. 8	**City of Tracy**	NM		NM	NM
(ASR)					

TABLE 5
UNCONFINED AQUIFER GROUNDWATER QUALITY

WELL ID	Owner	DATE SAMPLED	TDS (lab) (mg/L)	TDS (est) (mg/L)	EC uhmos/cm	pH	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	CO3 (mg/L)	HCO3 (mg/L)	SO4 (mg/L)	Cl (mg/L)	NO3 as N (mg/L)	As (ug/L)	B mg/L	Total Cr (ug/L)	F mg/L	Fe (mg/L)	Mn (ug/L)	Alpha Gross ico curies/lite
		MCLs	500*	500*	900*	6-8							250*	250*	10	50		50	2	0.3	50	100
MRL-2W	DWR	5/9/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
GLWL-1W	DWR	5/9/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
LMO65C	Tracy Army Depot	3/9/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
LM124C	Tracy Army Depot	3/9/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
LMO47C	Tracy Army Depot	3/9/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
WELL BW-3	Spreckles Sugar	5/11/2005	920			NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
WELL BW-4	Spreckles Sugar	5/11/2005	420			NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
WELL WP-7	Spreckles Sugar	5/11/2005	2300			NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Well BC-19	Georgia-Pacific	3/15/2005	519			NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Well BC-20	Georgia-Pacific	3/15/2005	780			NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Well MW-23	Georgia-Pacific	5/18/2005	810			NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW1	Dick's Exxon	7/7/2006		1751		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-2	7-11 #32262	5/9/2005		352		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-4B	Pombo Ranch	5/10/2005		193		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-1	Deuel Vocational Institute	3/9/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-101	George's Service	4/1/2005		1124		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-5	Sinclair Trucking	4/11/2005		2181		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-2	JOE'S TRUCK PLAZA	3/9/2005		91		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-8	JOE'S TRUCK PLAZA	9/8/2005	NM	NM		NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

TABLE 6
CONFINED AQUIFER GROUNDWATER QUALITY

WELL ID	Owner	DATE SAMPLED	TDS (mg/L)	EC (uhmos/cm)	pH	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	CO3 (mg/L)	HCO3 (mg/L)	SO4 (mg/L)	Cl (mg/L)	NO3 as N (mg/L)	As (ug/L)	B mg/L	Total Cr (ug/L)	F mg/L	Fe (mg/L)	Mn (ug/L)	Alpha Gross (pico curies/liter)
		MCLs	500*	900*	6-8							250*	250*	10	50		50	2	0.3	50	100
MW-1A	**City of Tracy**	19-Apr-05	420	647	8.3	26	8.7	100	1.8	1.97	152	120	60	<0.50	6.9	0.9	<1.0	<0.1	1.4	100	<3.00
MW-1B	**City of Tracy**	19-Apr-05	660	976	8.1	61	29	110	3.6	1.26	154	250	100	<0.50	<2.0	1.6	<1.0	0.13	1.5	240	<3.00
MW-1C	**City of Tracy**	19-Apr-05	570	875	7.5	34	28	110	4	1.181	88.1	230	110	<0.50	<2.0	1.1	<1.0	<0.1	1.7	94	<3.00
MW-2A	**City of Tracy**	19-Apr-05	410	637	8.2	27	10	97	1.5	1.05	102	140	63	<0.50	4	0.87	<1.0	<0.1	1.5	65	<3.00
MW-2B	**City of Tracy**	19-Apr-05	840	1160	8	92	36	120	4.1	1.25	193	310	120	1.10	<2.0	1.9	39	0.15	5.9	43	<3.00
MW-2C	**City of Tracy**	19-Apr-05	730	1050	8	76	33	110	4.4	0.975	150	280	110	0.93	<2.0	1.4	7.2	0.14	8.8	45	<3.00
MW-3A	**City of Tracy**	19-Apr-05	350	587	8.6	9.2	12	95	3.3	1.54	59.7	120	83	<0.50	<2.0	0.92	<1.0	<0.1	1	48	<3.00
MW-3B	**City of Tracy**	19-Apr-05	400	741	9.0	3.3	19	120	4	7.73	119	66	140	<0.50	<2.0	1.2	<1.0	<0.1	1	34	<3.00
MW-3C	**City of Tracy**	19-Apr-05	500	804	8.8	11	28	110	4.4	2.12	51.7	200	110	<0.50	<2.0	1.4	<1.0	<0.1	1.5	56	<3.00
MW-4A	**City of Tracy**	19-Apr-05	350	613	9.1	4.1	8.6	110	2.4	7.7	94.1	93	78	<0.50	<2.0	0.8	<1.0	<0.1	0.52	<20	<3.00
MW-4B	**City of Tracy**	19-Apr-05	300	569	9.1	4.7	12	89	3.2	6.87	84	90	70	<0.50	<2.0	0.77	<1.0	0.14	0.34	22	<3.00
MW-4C	**City of Tracy**	19-Apr-05	520	875	8.0	14	28	120	4.6	0.276	42.4	221	110	<0.50	<2.0	0.98	2	<0.1	0.32	44	<3.00
MW-5A	**City of Tracy**	19-Apr-05	830	1250	8.3	65	32	150	4.4	1.89	146	320	130	<0.50	3.8	1.2	1.8	0.11	0.93	170	<3.00
MW-5B	**City of Tracy**	19-Apr-05	660	1050	8.1	52	24	130	4.3	1.23	150	240	100	2.12	<2.0	1.1	5.1	<0.1	0.69	59	<3.00
MW-5C	**City of Tracy**	19-Apr-05	1080	1940	8.1	52	24	290	5.6	0.753	92	110	510	<0.50	3.4	1.1	2.8	<0.1	1.4	79	<3.00
MW-6A	**City of Tracy**	19-Apr-05	570	958	8.1	16	32	140	5.2	0.528	64.5	230	130	<0.5	<2.0	0.97	2	<0.1	1.50	85	<3.00
MW-6B	**City of Tracy**	19-Apr-05	530	778	9.1	11	20	150	4.1	4.23	51.7	200	130	<0.5	<2.0	0.93	1.3	<0.1	0.36	29	<3.00
MW-6C	**City of Tracy**	19-Apr-05	500	782	9	4	7.7	170	3.4	6.3	97.6	110	160	<0.5	<2.0	1.1	<0.5	<0.1	1.1	<20.0	<3.00

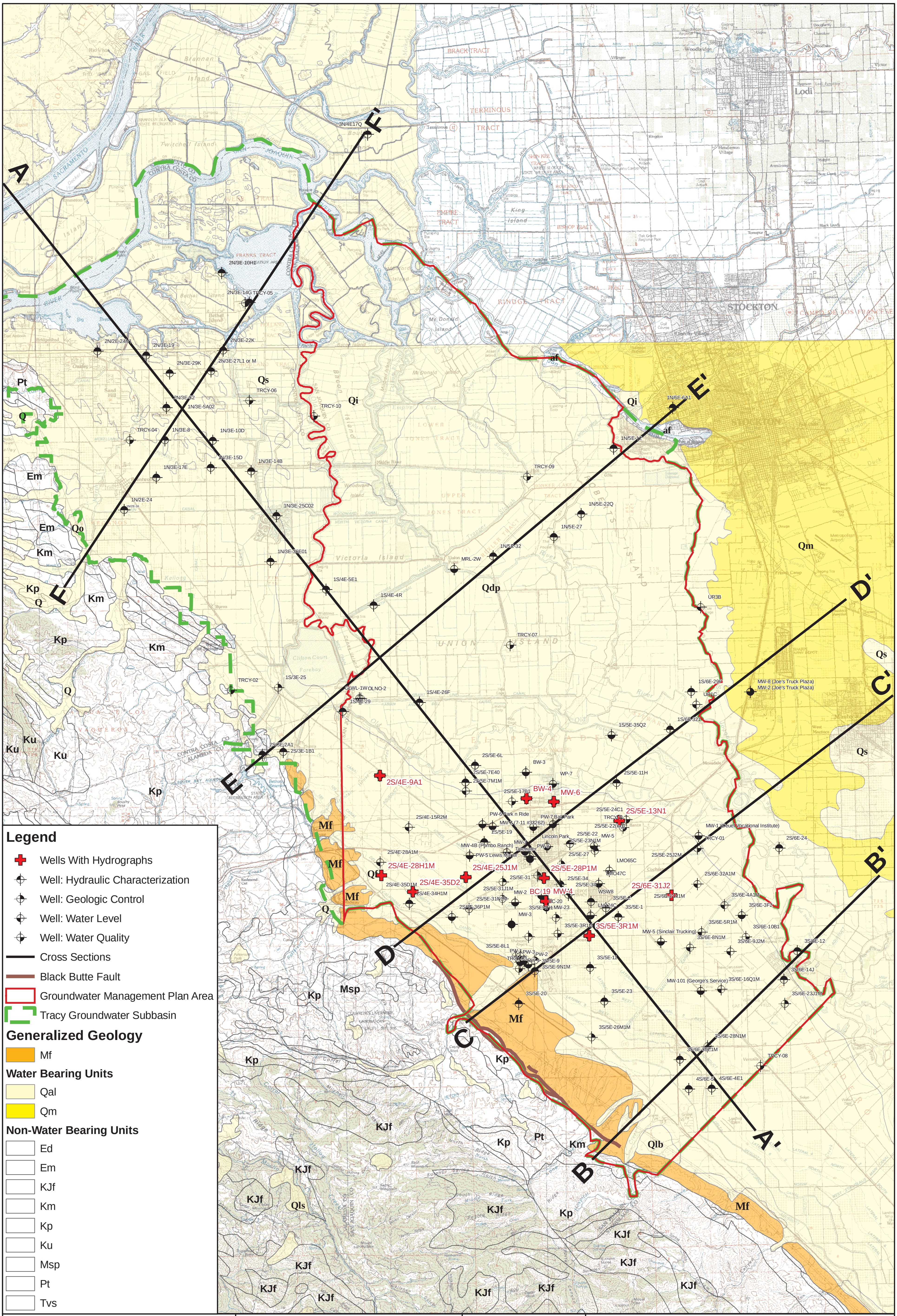
TABLE 7
POTENTIAL ADDITIONAL WELLS TO BE INCLUDED INTO THE MONITORING NETWORK

Well ID	Owner	Annular Seal (Feet)	Filter Pack Interval (Feet)	Screen Interval (Feet)	Aquifer Monitored
02S04E25J001M	**DWR**			136-156	UNCONFINED
02S04E28A001M	**DWR**			NA	UNCONFINED
02S04E34H001M	**DWR**				UNCONFINED
02S04E35D002M	**DWR**			200-330	UNCONFINED
02S05E07M001M	**DWR**			185-205	UNCONFINED
02S05E23N001M	**DWR**			297-325	
02S05E28P001M	**DWR**			109-119	UNCONFINED
02S05E31N001M	**DWR**			154-574	UNCONFINED
02S06E10F001M	**DWR**			100-163	UNCONFINED
02S06E30H001M	**DWR**			NA	
02S06E31J002M	**DWR**			20-40	UNCONFINED
02S06E32A001M	**DWR**			70-90	UNCONFINED
02S07E31N001M	**DWR**			130-226	UNCONFINED
03S05E04H001M	**DWR**			120-140	UNCONFINED
03S5E26M001M	**DWR**		1-199	159-194	UNCONFINED
02S04E28H001M	**DWR**			212-215	UNCONFINED
				239-243	
				252-254	
				308-319	
MRL-2W	**DWR**				UNCONFINED
GLWL-1W	**DWR**				UNCONFINED
03S05E3R001M	**DWR**			91-95	UNCONFINED
				116-124	
02S05E31J001M	**DWR**			51-56	UNCONFINED
				69-70	
02S05E28P001M	**DWR**	28-35		109-119	UNCONFINED
		44-45			
UR-3-B	**DWR**	2.5-10	12-20	15-20	UNCONFINED
UR-1-C	**DWR**	2.5-30	32-40	35-40	UNCONFINED
MRL-2W	**DWR**			61-81	UNCONFINED
GLWL-1W	**DWR**			74-89	UNCONFINED
TRCY-01	**GAMA**			384-480	CONFINED
TRCY-03	**GAMA**			420-890	CONFINED
TRCY-08	**GAMA**			320-340	CONFINED
TRCY-11	**GAMA**			310-400	CONFINED
Santos Ranch Water System (CSA 35) - Well 1	**S. J. CO.**				
Corral Hollow Water System - Wells 1 and 2	**S. J. CO.**				
The Orchard (CSA 19)	**S. J. CO.**				
Maurland Manor Water (CSA 44) Wells 2, 3, 4	**S. J. CO.**				
Par Country Estates (CSA 16)	**S. J. CO.**				
Duel Vocational Institute	**S. J. CO.**				
Tracy Golf and Country Club (Irrigation Wells)	**S. J. CO.**				

TABLE 8
WELLS RECOMMENDED FOR REACTIVATION

Well ID	Owner	Annular Seal (Feet)	Filter Pack Interval (Feet)	Screen Interval (Feet)	Aquifer Monitored
02S04E25J001M	**DWR**			136-156	UNCONFINED
02S04E28A001M	**DWR**			NA	UNCONFINED
02S04E34H001M	**DWR**				UNCONFINED
02S04E35D002M	**DWR**			200-330	UNCONFINED
02S05E07M001M	**DWR**			185-205	UNCONFINED
02S05E23N001M	**DWR**			297-325	
02S05E28P001M	**DWR**			109-119	UNCONFINED
02S05E31N001M	**DWR**			154-574	UNCONFINED
02S06E10F001M	**DWR**			100-163	UNCONFINED
02S06E30H001M	**DWR**			NA	
02S06E31J002M	**DWR**			20-40	UNCONFINED
02S06E32A001M	**DWR**			70-90	UNCONFINED
02S07E31N001M	**DWR**			130-226	UNCONFINED
03S05E04H001M	**DWR**			120-140	UNCONFINED
03S5E26M001M	**DWR**		1-199	159-194	UNCONFINED
02S04E28H001M	**DWR**			212-215	UNCONFINED
				239-243	
				252-254	
				308-319	
03S05E3R001M	**DWR**			91-95	UNCONFINED
				116-124	
02S05E31J001M	**DWR**			51-56	UNCONFINED
				69-70	
02S05E28P001M	**DWR**	28-35		109-119	UNCONFINED
		44-45			
UR-3-B	**DWR**	2.5-10	12-20	15-20	UNCONFINED
UR-1-C	**DWR**	2.5-30	32-40	35-40	UNCONFINED
MRL-2W	**DWR**			61-81	UNCONFINED
GLWL-1W	**DWR**			74-89	UNCONFINED

Figures



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Tracy Regional
Groundwater Management Plan

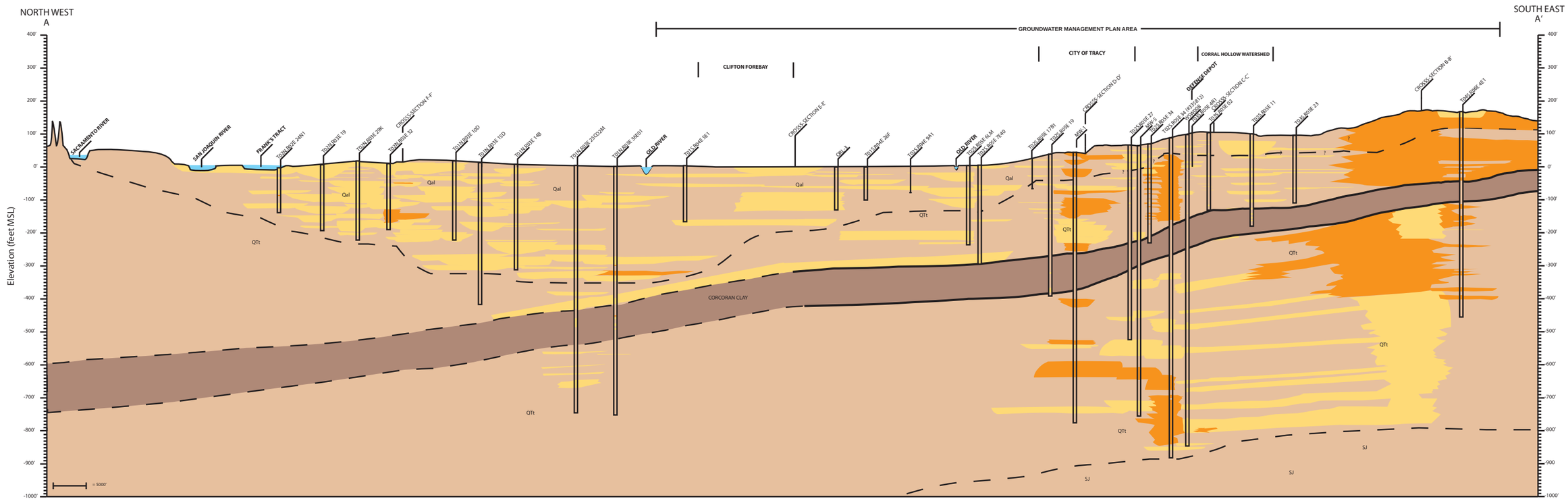
San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

WELL LOCATIONS AND
GENERALIZED GEOLOGY IN
TRACY GROUNDWATER SUBBASIN

JANUARY 2007

FIGURE 1



LEGEND

Qal: Alluvium
QTt: Tulare Fm
Mf: Fanglomerate
Kp: Panoche Fm
SJ: San Joaquin Clays

GRAVELS
SANDS
SILT/CLAY
CORCORAN CLAY

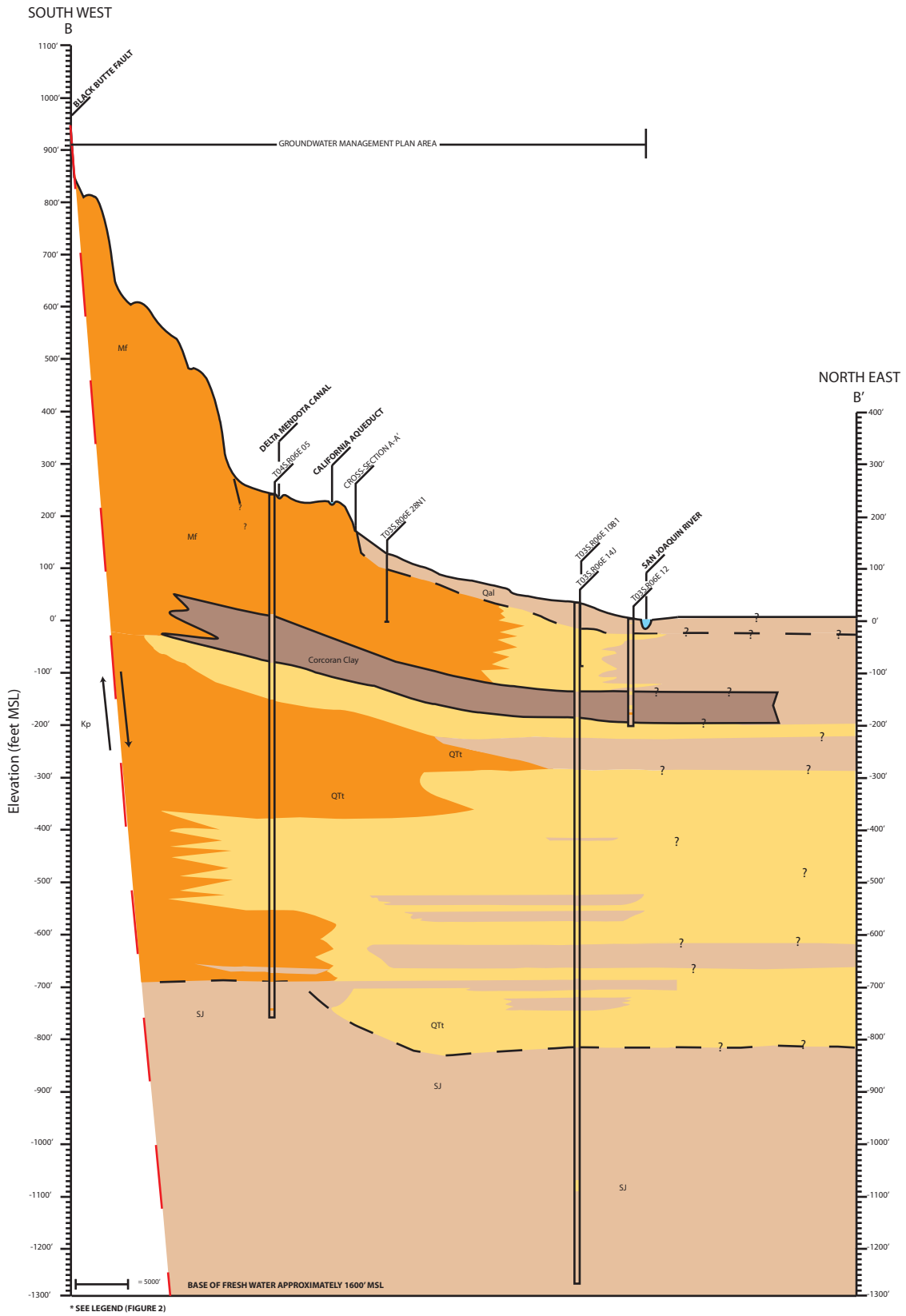
Fault, arrows showing direction of movement

Geologic contact. Dashed where inferred, question mark where unkown

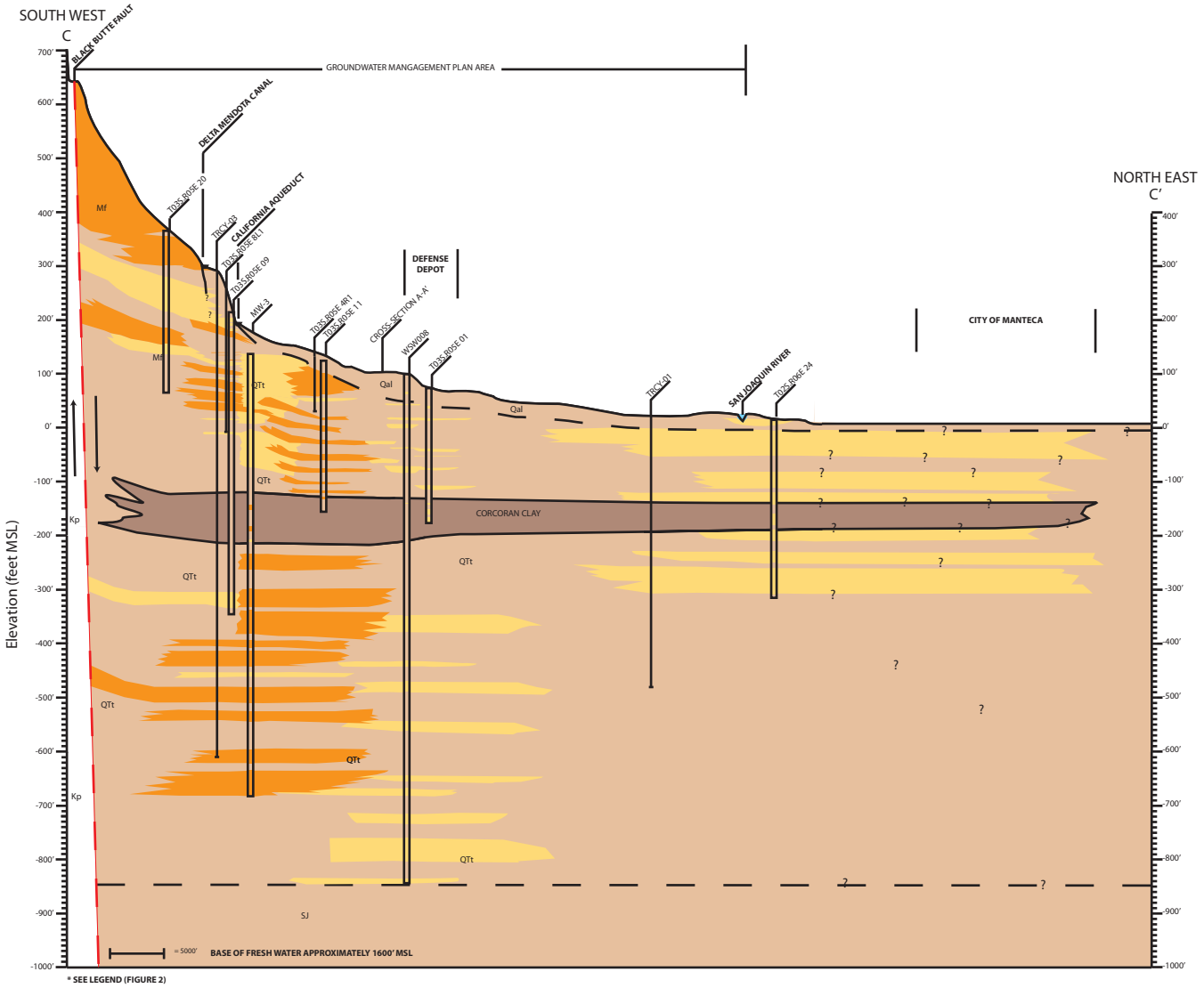
= Wells used for geology, hydrogeology interpretation and water quality and levels where available.

= Wells used for water quality and water level data.

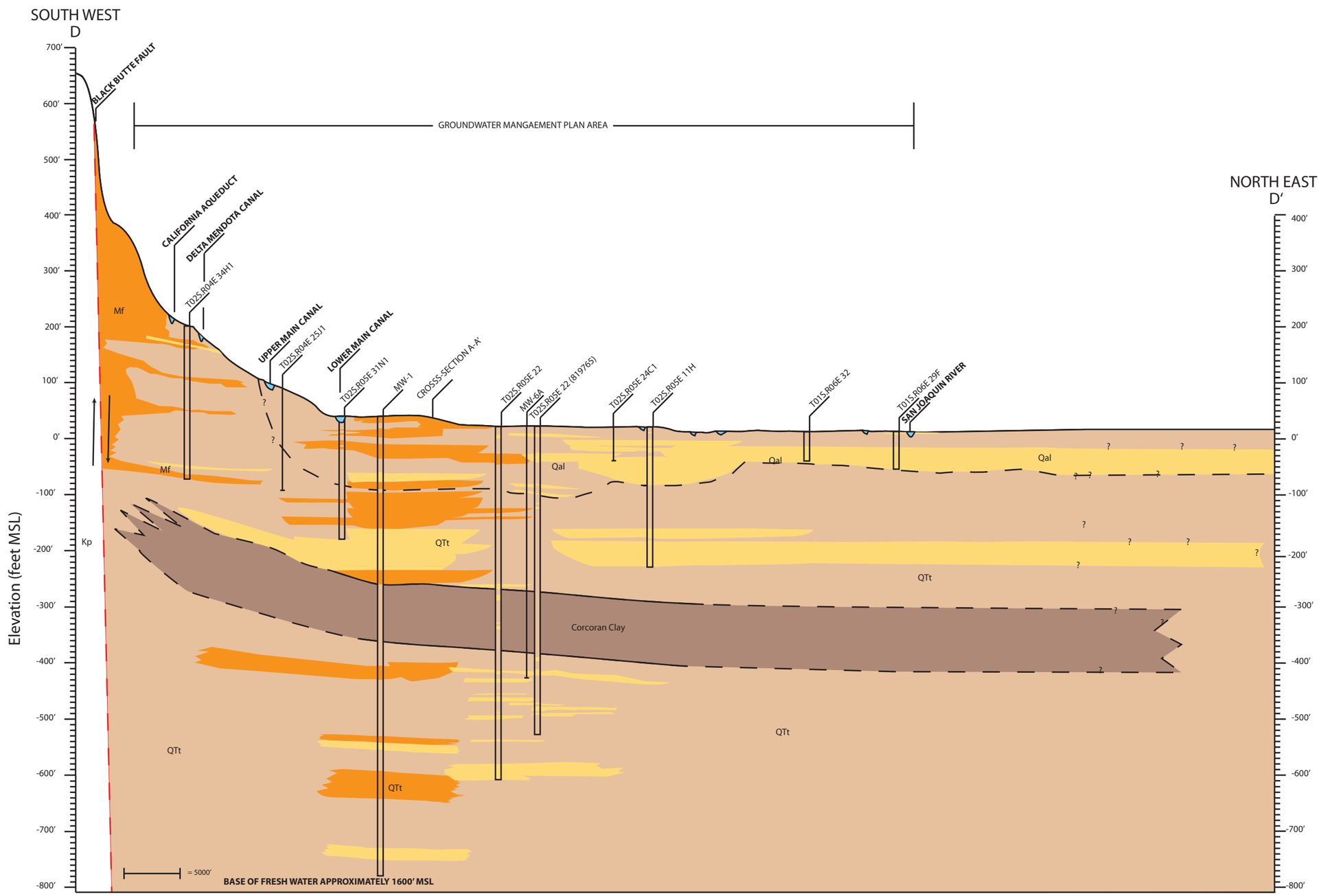
Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION A-A'
City Of Tracy		JANUARY 2007 FIGURE 2



Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION B-B'
City Of Tracy		JANUARY 2007 FIGURE 3

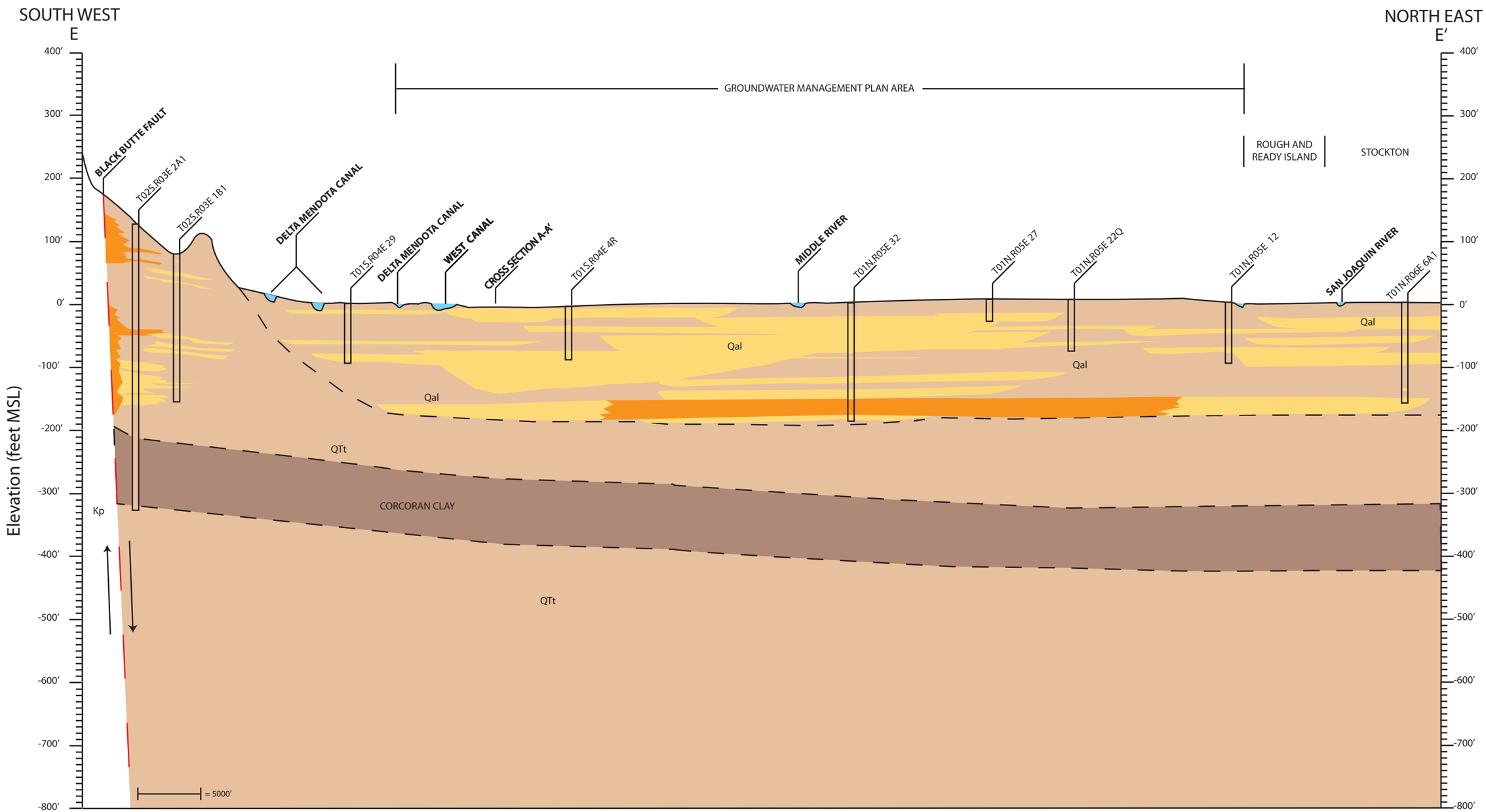


Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION C-C'
City Of Tracy		JANUARY 2007 FIGURE 4



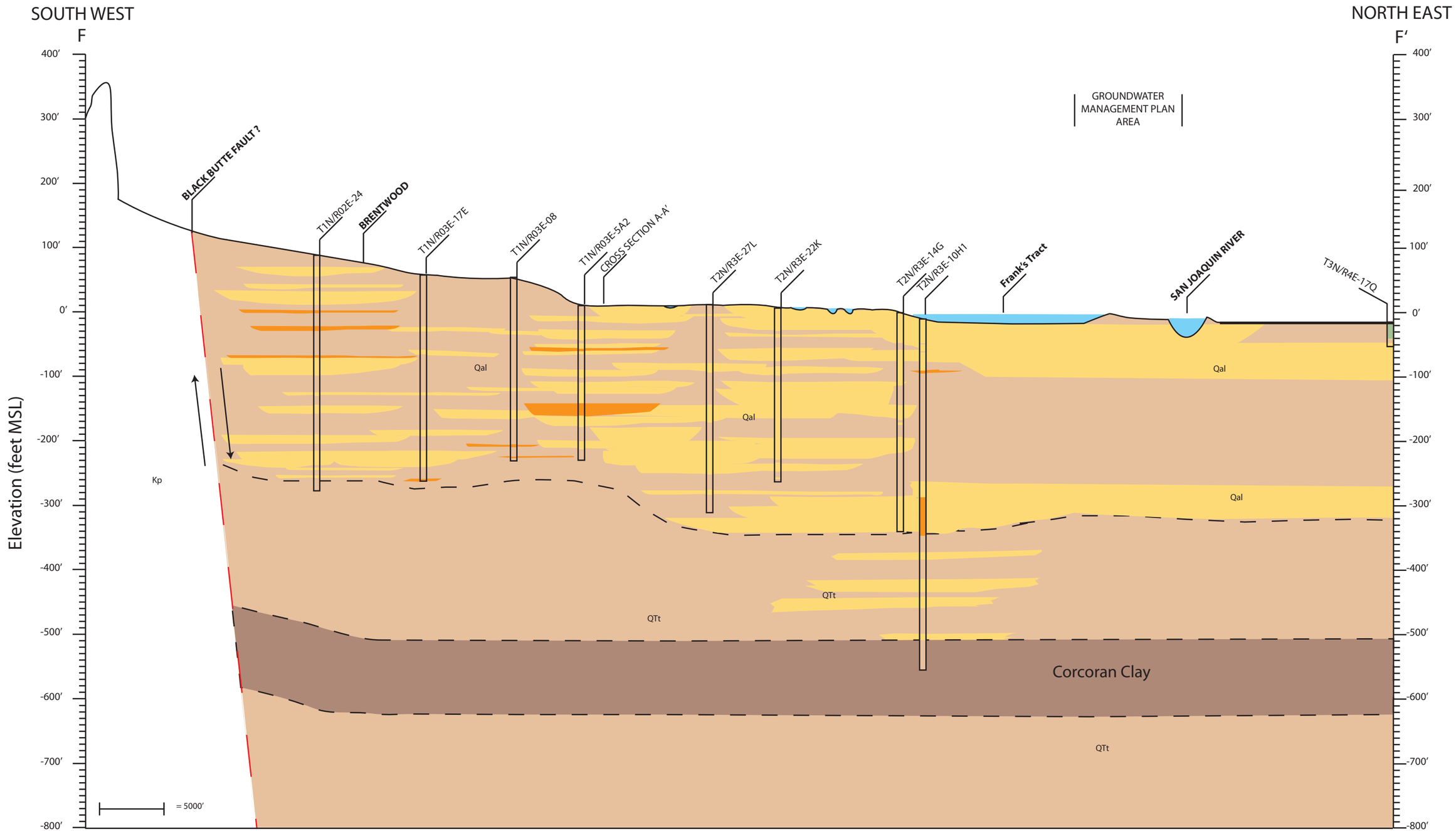
* SEE LEGEND (FIGURE 2)

Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION D-D'
City Of Tracy		JANUARY 2007 FIGURE 5



* SEE LEGEND (FIGURE 2)

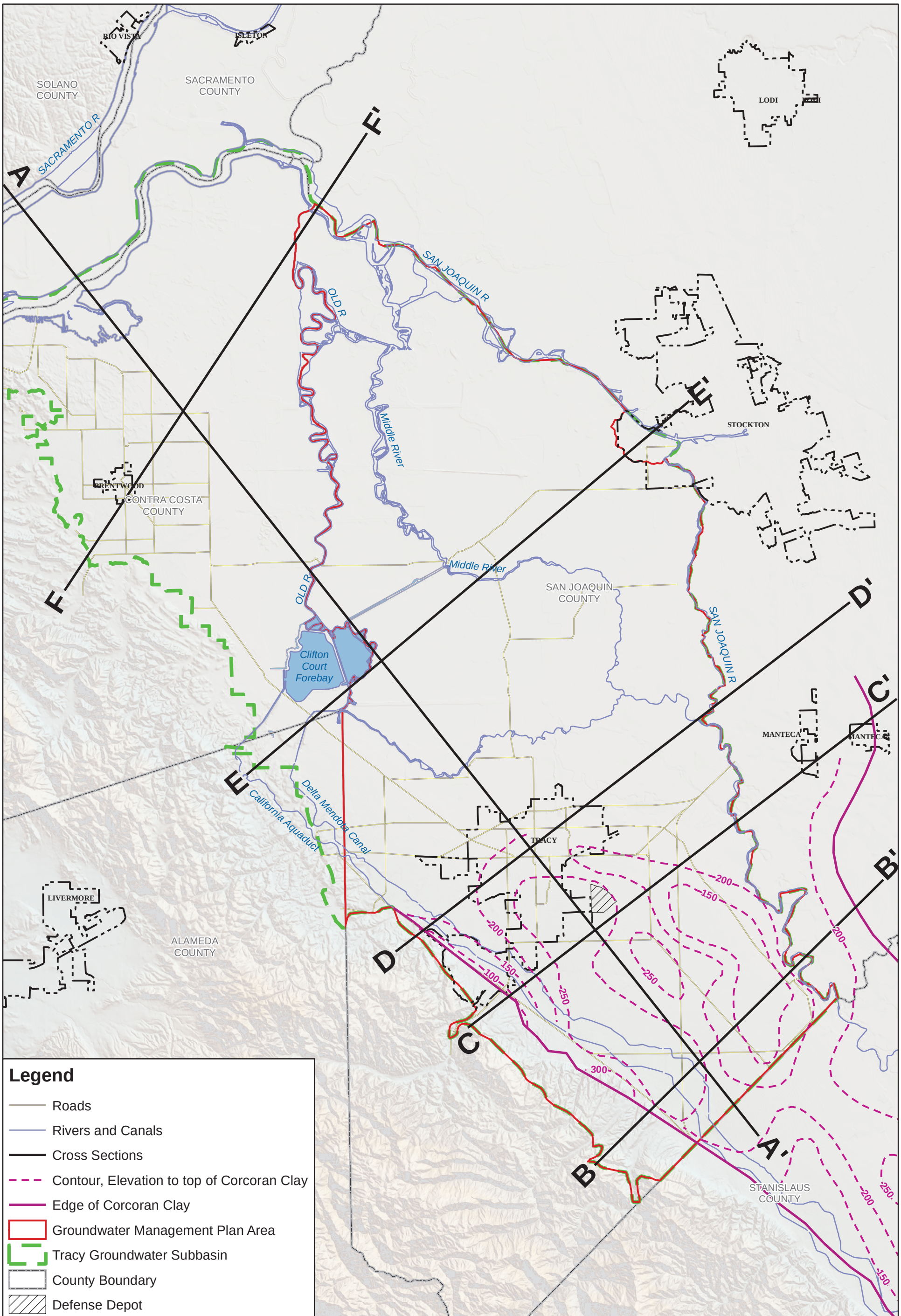
Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION E-E'
City Of Tracy		JANUARY 2007 FIGURE 6



*** SEE LEGEND (FIGURE 2)**

PEET/ORGANICS

Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION F-F'
City Of Tracy		JANUARY 2007 FIGURE 7



Tracy Regional Groundwater Management Plan

San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

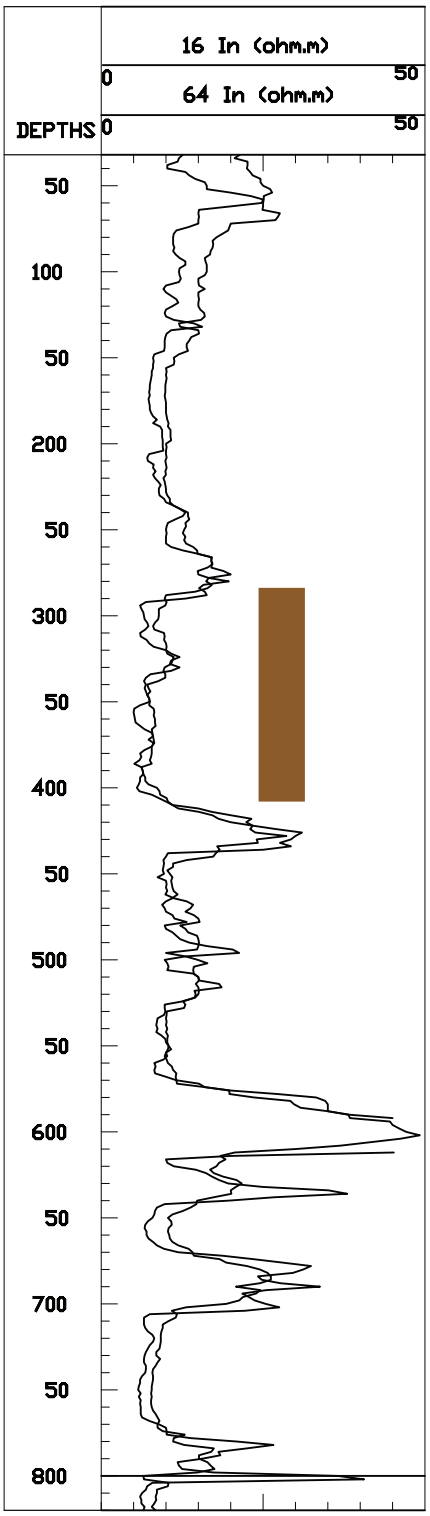
EXTENT OF CORCORAN CLAY

JANUARY 2007

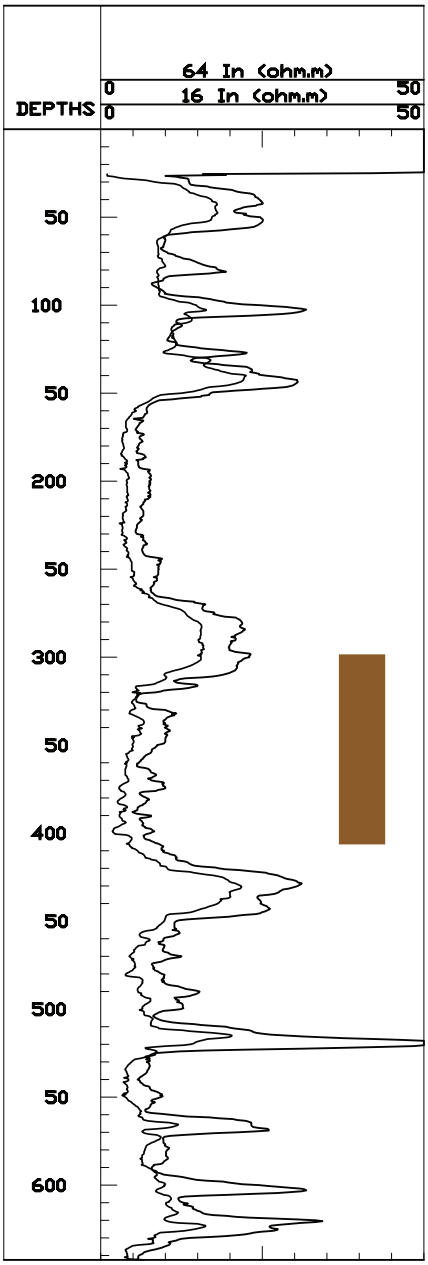
FIGURE 8

15-Jan-07 S:/GIS/Projects/060260/Tracy_eclay_fig8_.mxd

MW-5C

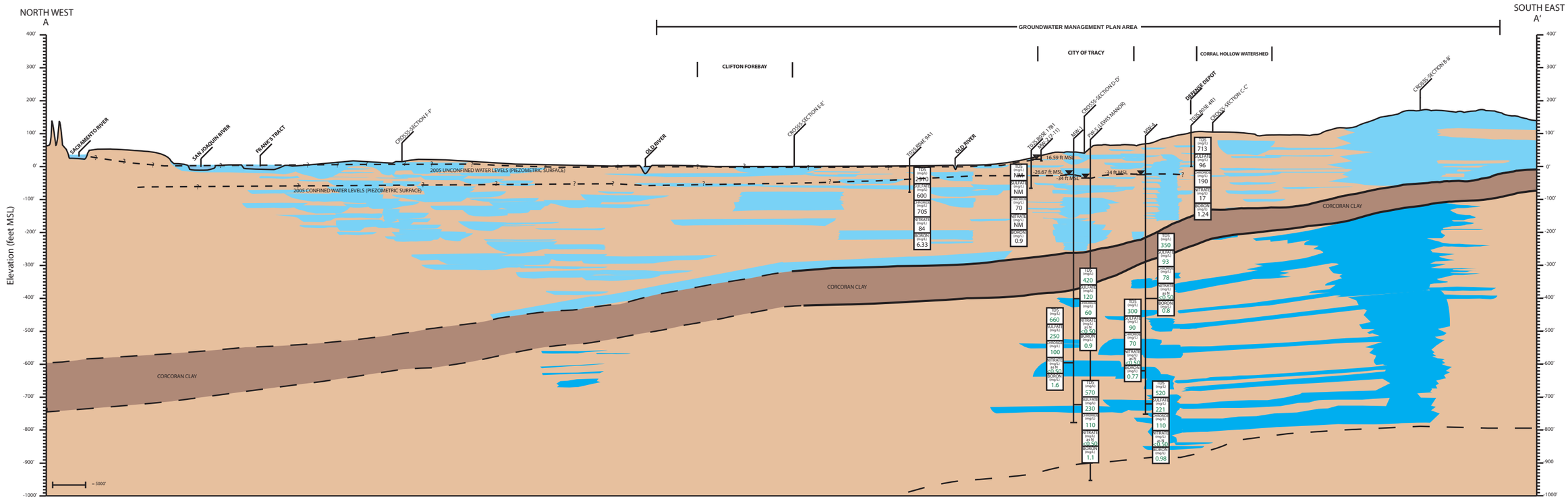


MW-6B



CORCORAN CLAY

Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	ELECTRIC LOG RESPONSE TO CORCORAN CLAY AT MW-5 AND MW-6
City Of Tracy		JANUARY 2007 FIGURE 9

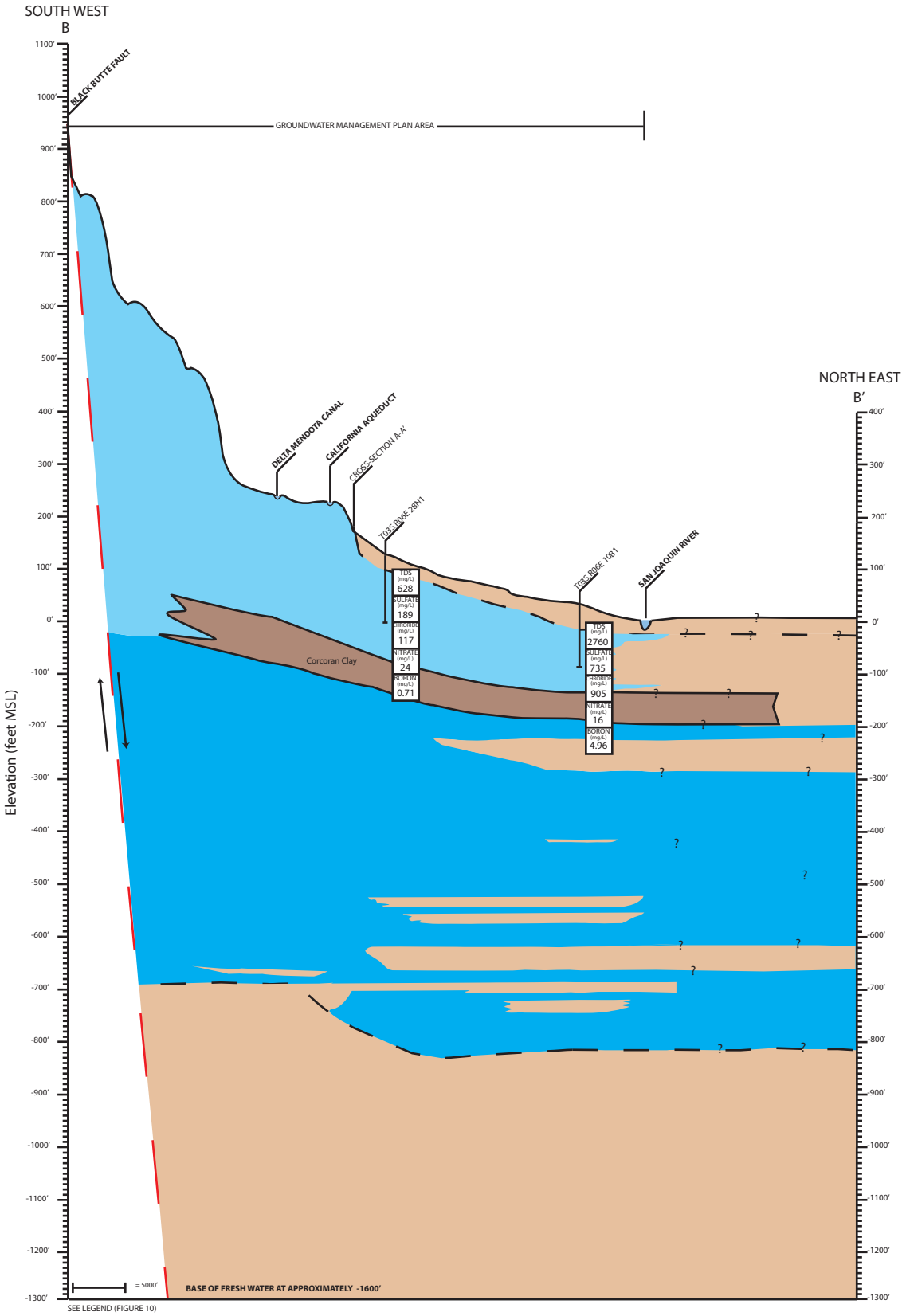


LEGEND

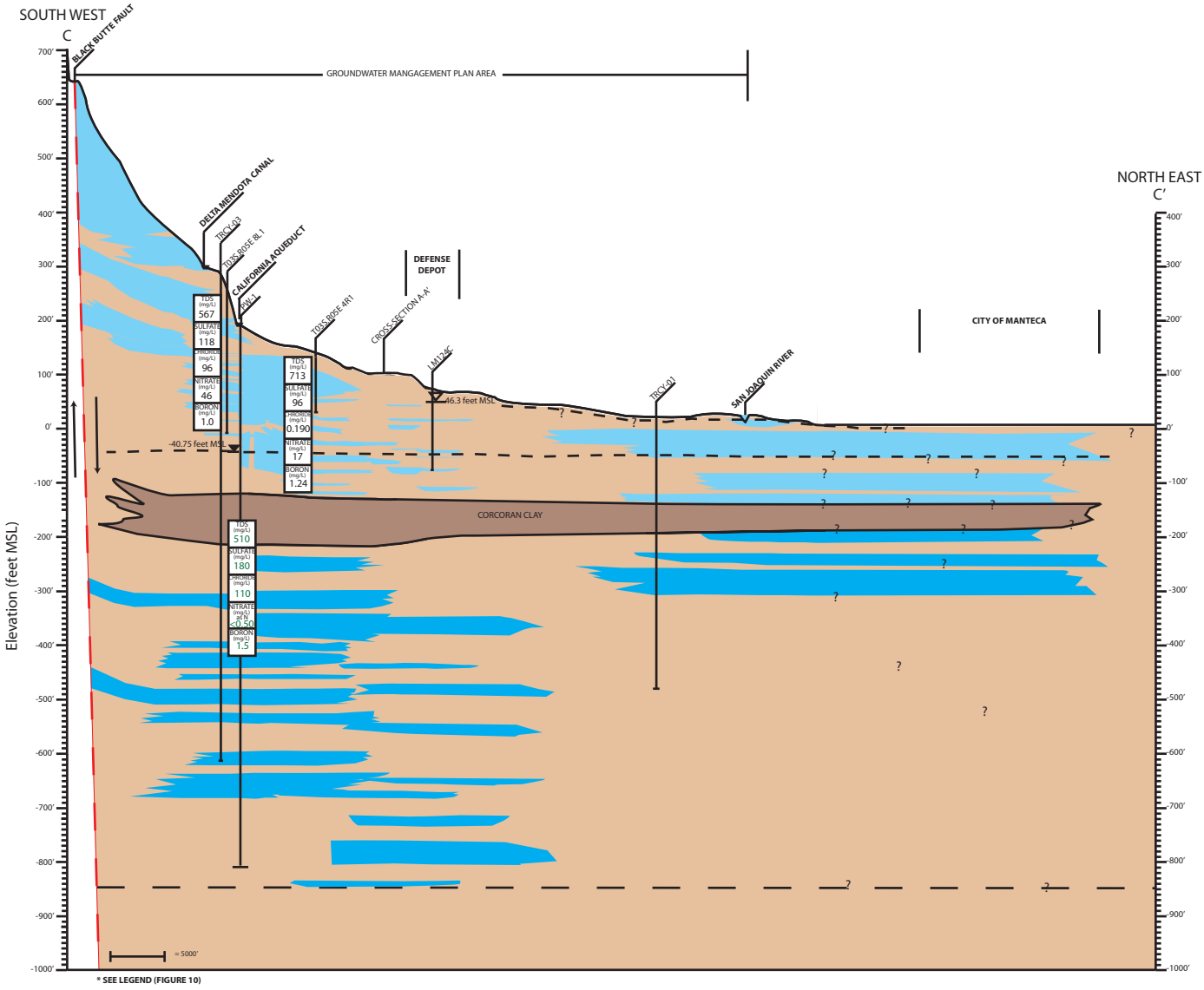
- GRAVELS
- SANDS
- SILT/CLAY
- CORCORAN CLAY
- UNCONFINED AQUIFER
- CONFINED AQUIFER
- Fault, arrows showing direction of movement
- Piezometric surface Dashed where inferred, question mark where unkown
- Confined water Surface Elevation (feet MSL)
- Unconfined water Surface Elevation (feet MSL)
- Wells used for water quality and water level data.

Water Chemistry data gathered from 1968. Measurements in green represent 2005 data.

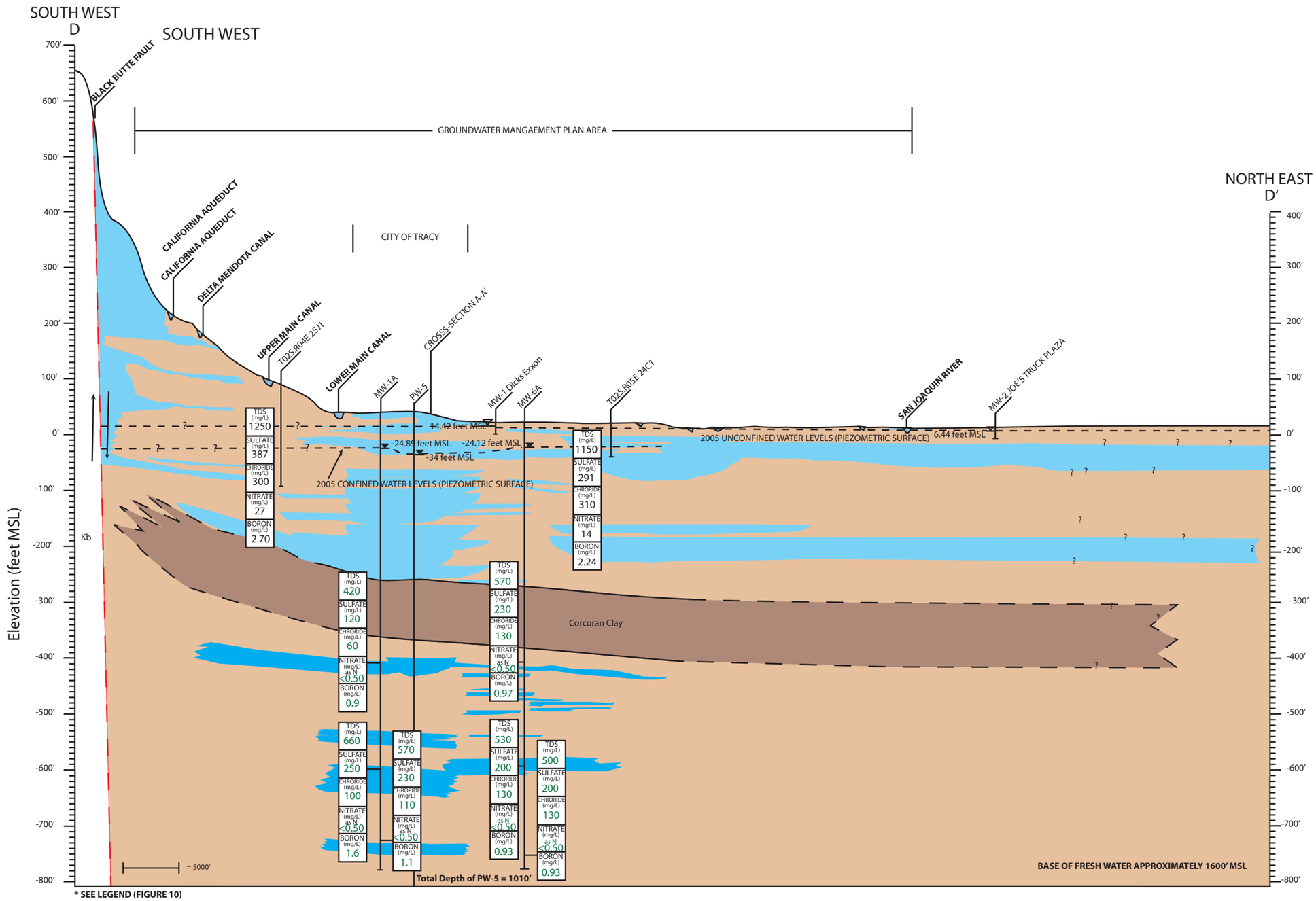
Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	AQUIFER PROFILE A-A'
City Of Tracy		JANUARY 2007 FIGURE 10



Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	AQUIFER PROFILE B-B'
City Of Tracy		JANUARY 2007 FIGURE 11

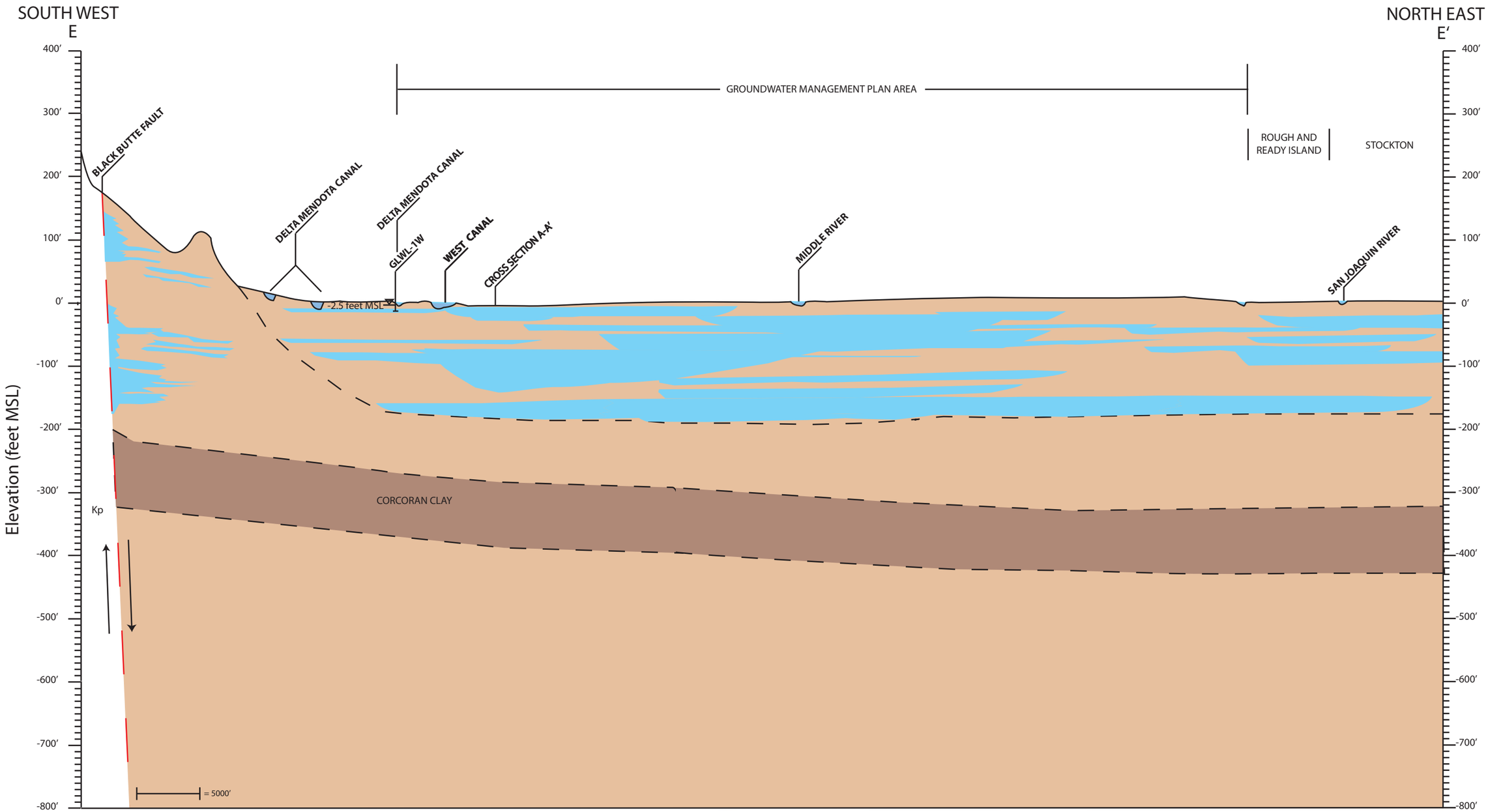


Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	AQUIFER PROFILE C-C'
City Of Tracy		JANUARY 2007 FIGURE 12



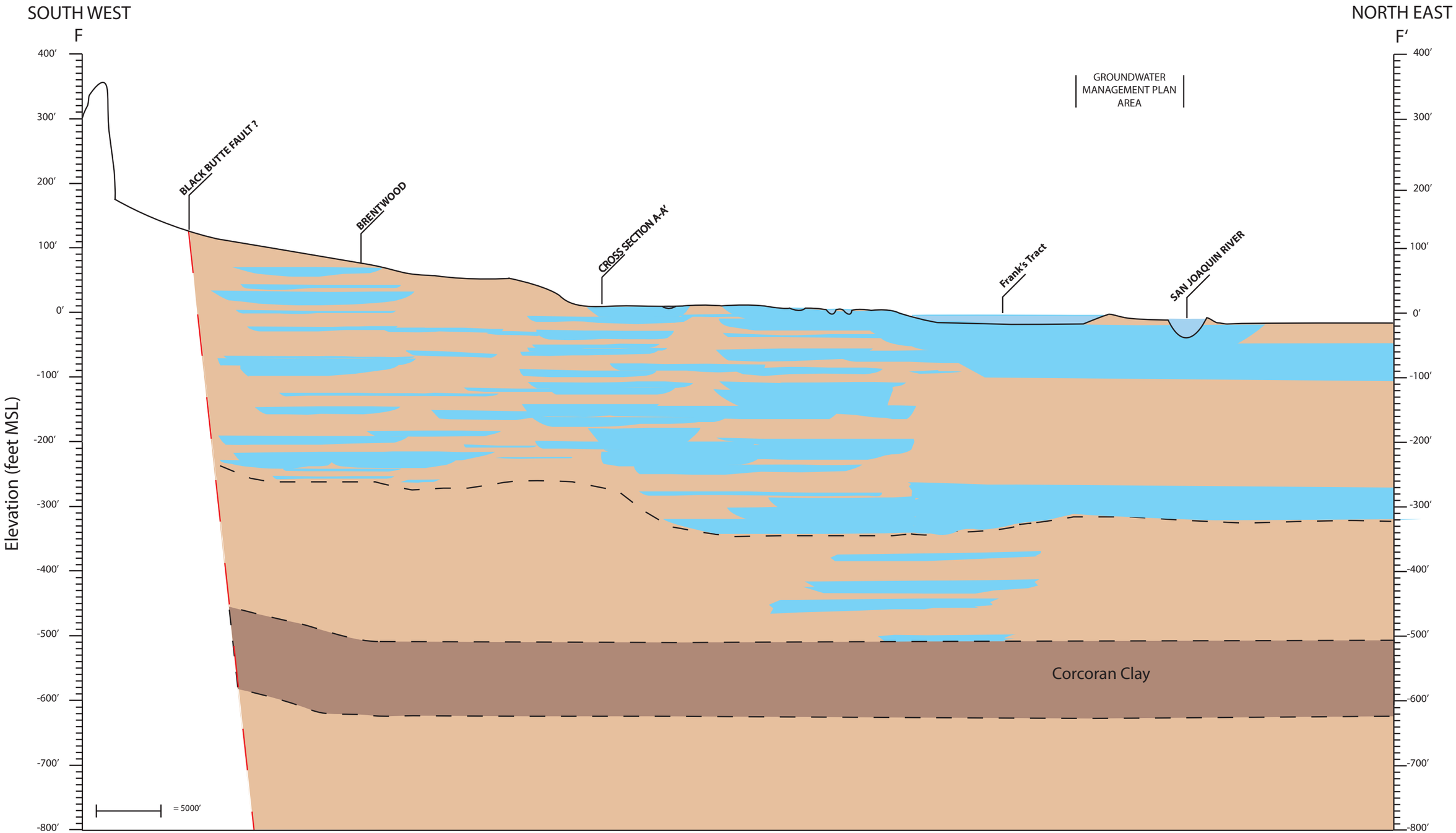
* SEE LEGEND (FIGURE 10)

Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	AQUIFER PROFILE D-D'
City Of Tracy		JANUARY 2007 FIGURE 13



* SEE LEGEND (FIGURE 10)

Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	AQUIFER PROFILE E-E'
City Of Tracy		JANUARY 2007 FIGURE 14



* SEE LEGEND (FIGURE 10)

Hydrogeologic Assessment	GEI Consultants Bookman-Edmonston Division	AQUIFER PROFILE F-F'
City Of Tracy		JANUARY 2007 FIGURE 15

FIGURE 16
UNCONFINED AQUIFER HYDROGRAPH

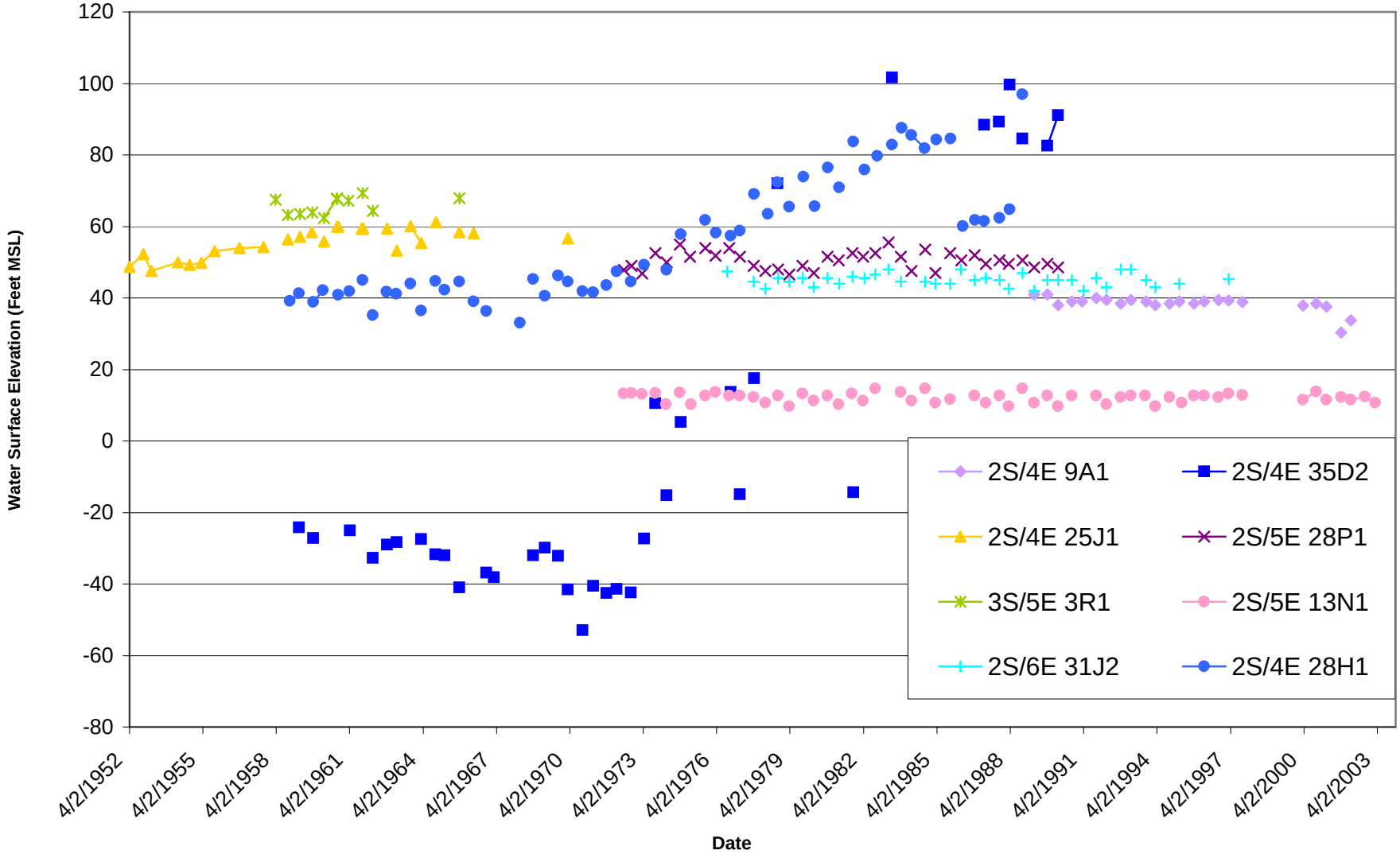


FIGURE 17
COMPARISON OF UNCONFINED AND CONFINED AQUIFER GROUNDWATER LEVELS
WELLS BC-19 AND MW-4A

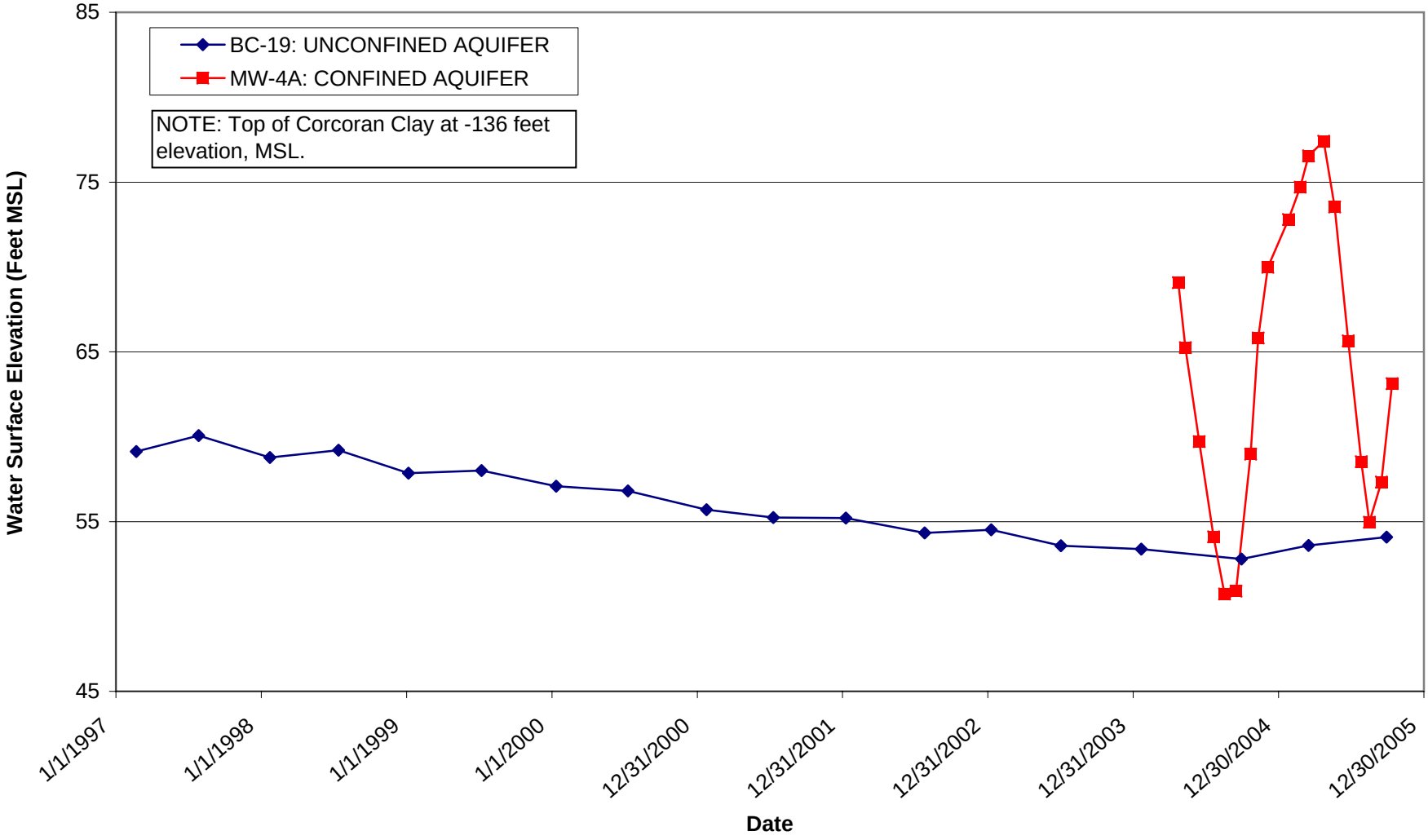
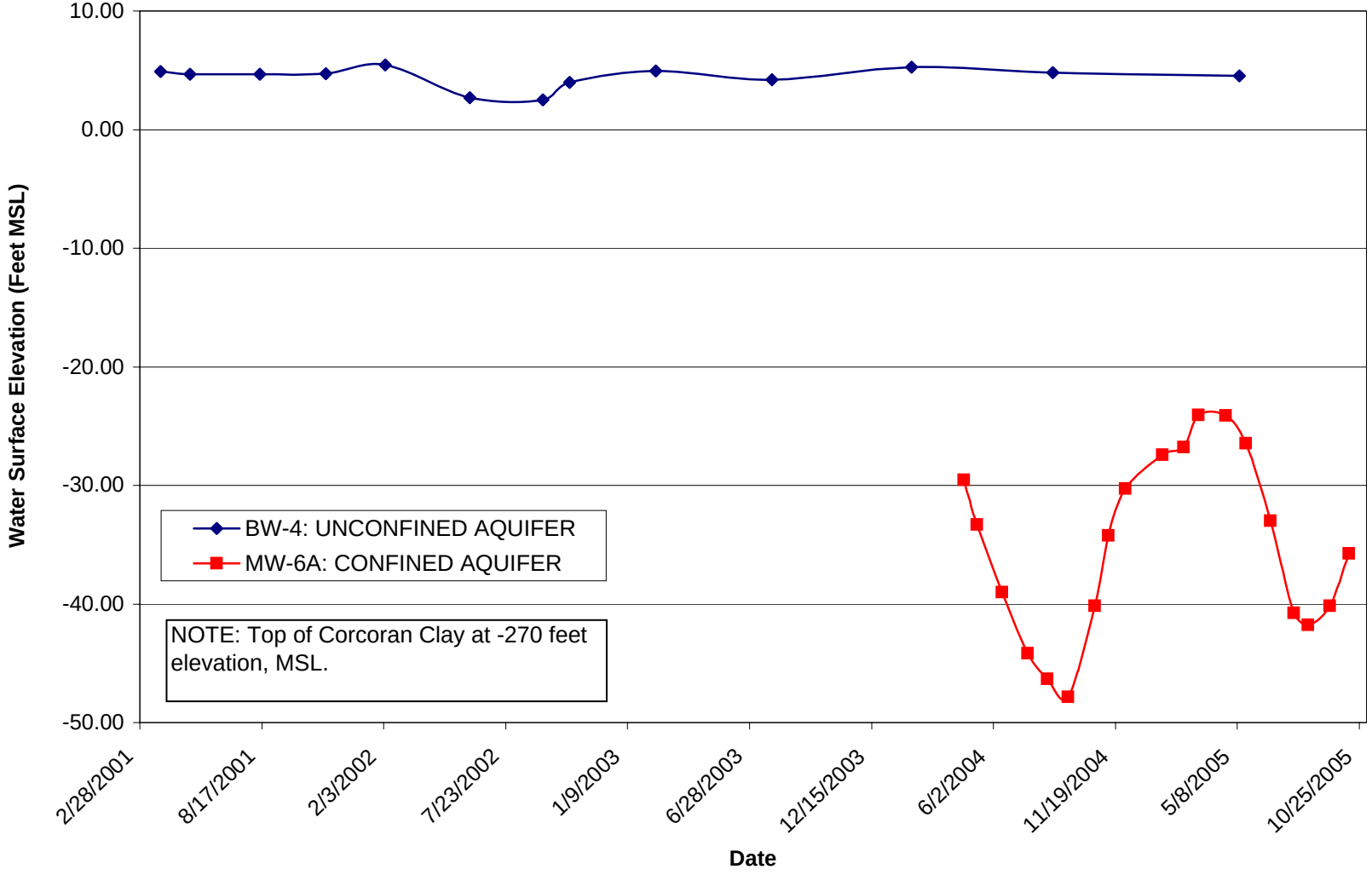
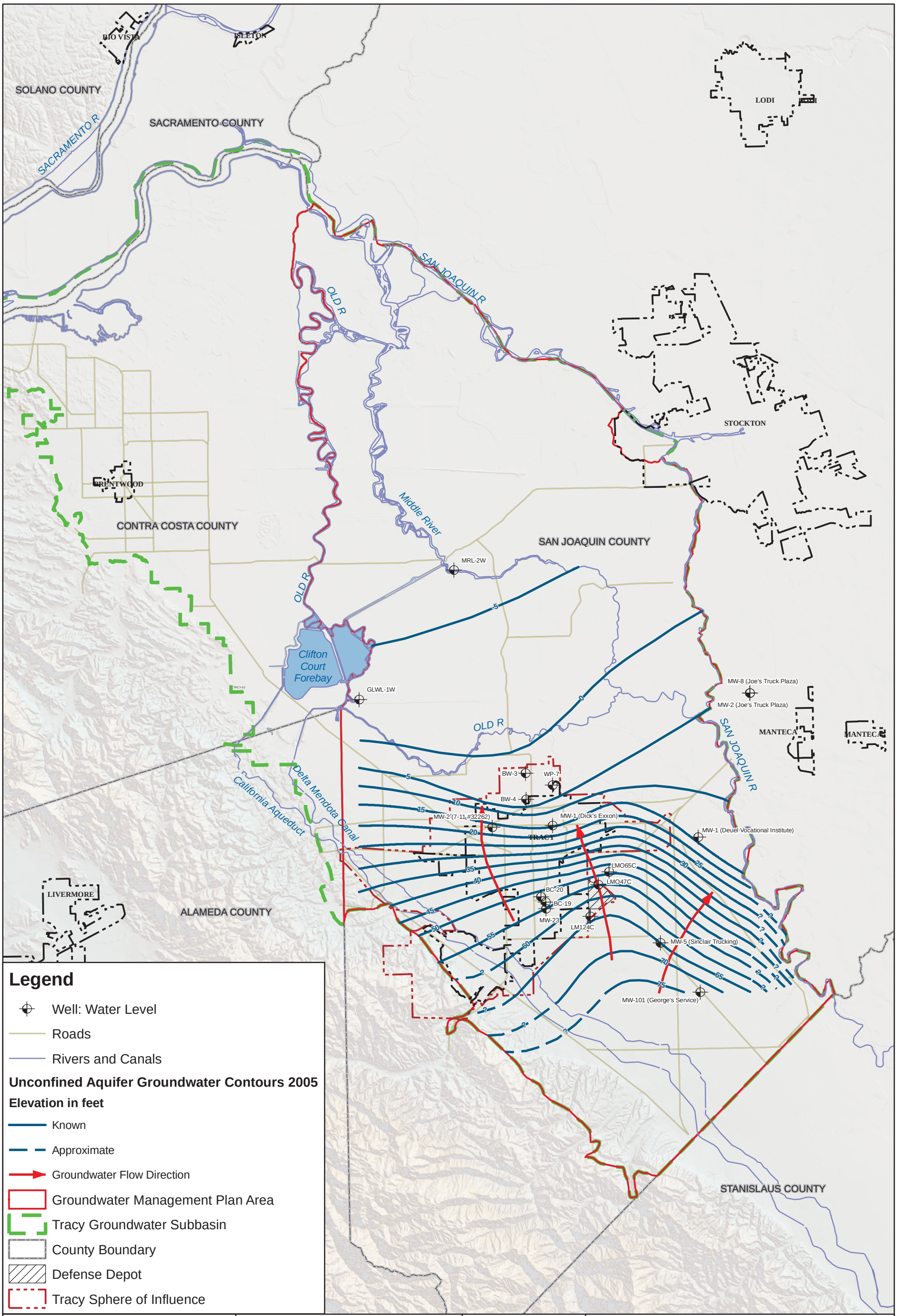


FIGURE 18
COMPARISON OF UNCONFINED AND CONFINED GROUNDWATER LEVELS
WELLS BW-4 AND MW-6A





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San Joaquin County, California

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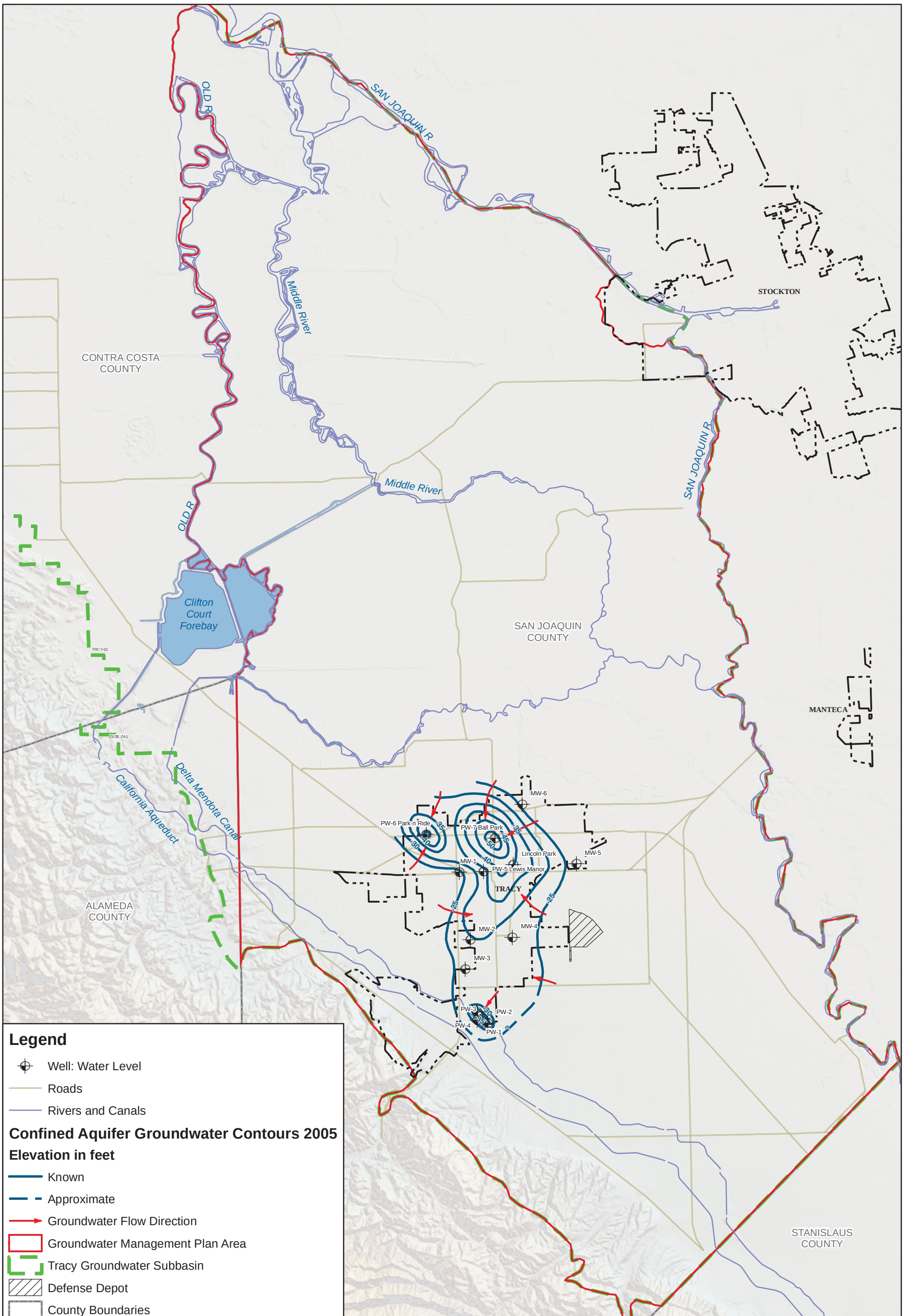
UNCONFINED AQUIFER GROUNDWATER CONTOURS, SPRING 2005

JANUARY 2007

FIGURE 19

19-Jan-07 S:/GIS/Projects/060260/Tracy_gw2005unconf_cont_fig19.mxd



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CONTOUR MAP OF SPRING 2005 CONFINED AQUIFER GROUNDWATER LEVELS

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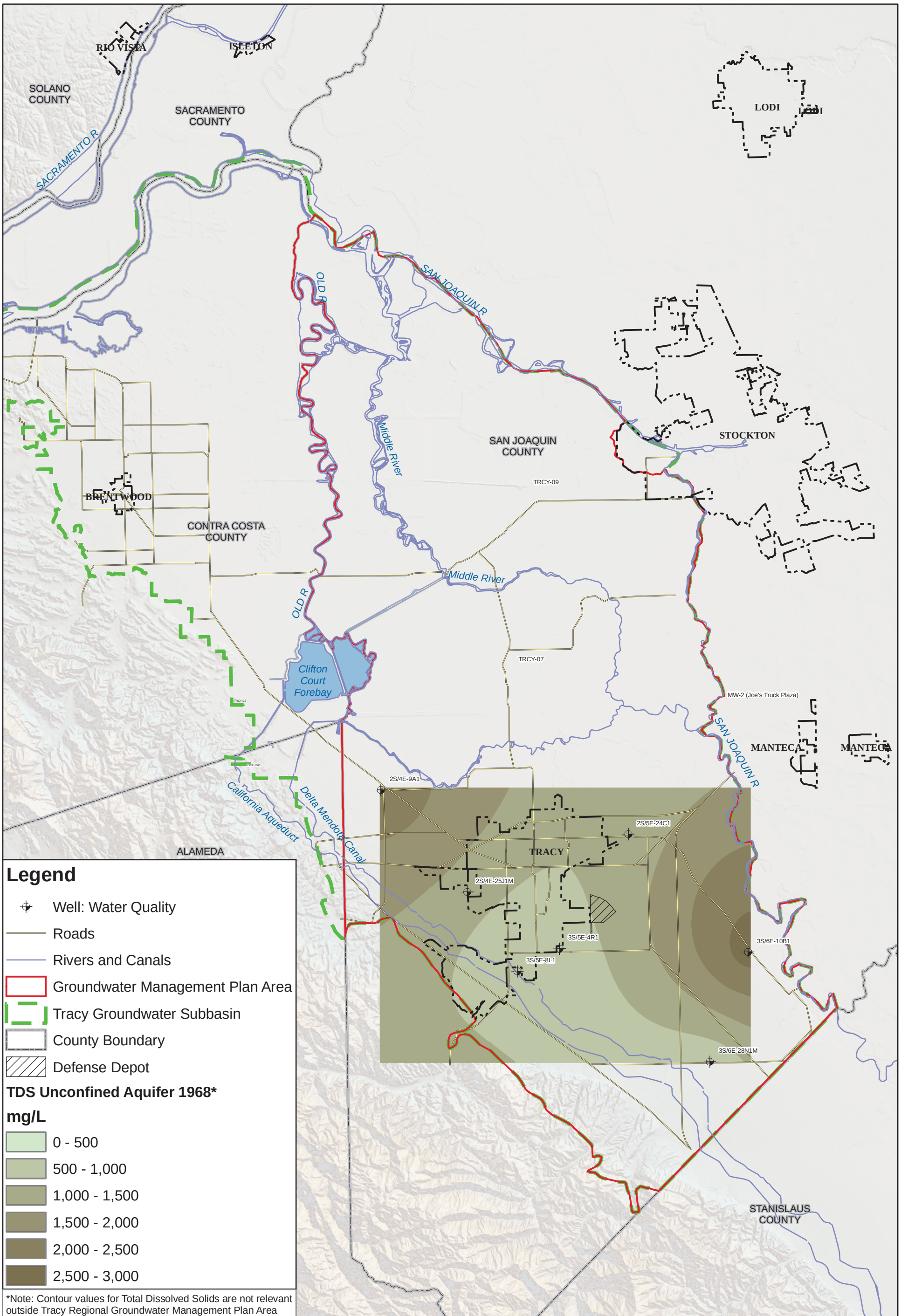
FIGURE 20

19-Jan-07 S:/GIS/Projects/060260/Tracy_gw2005conf_cont_fig20.mxd



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San Joaquin County, California

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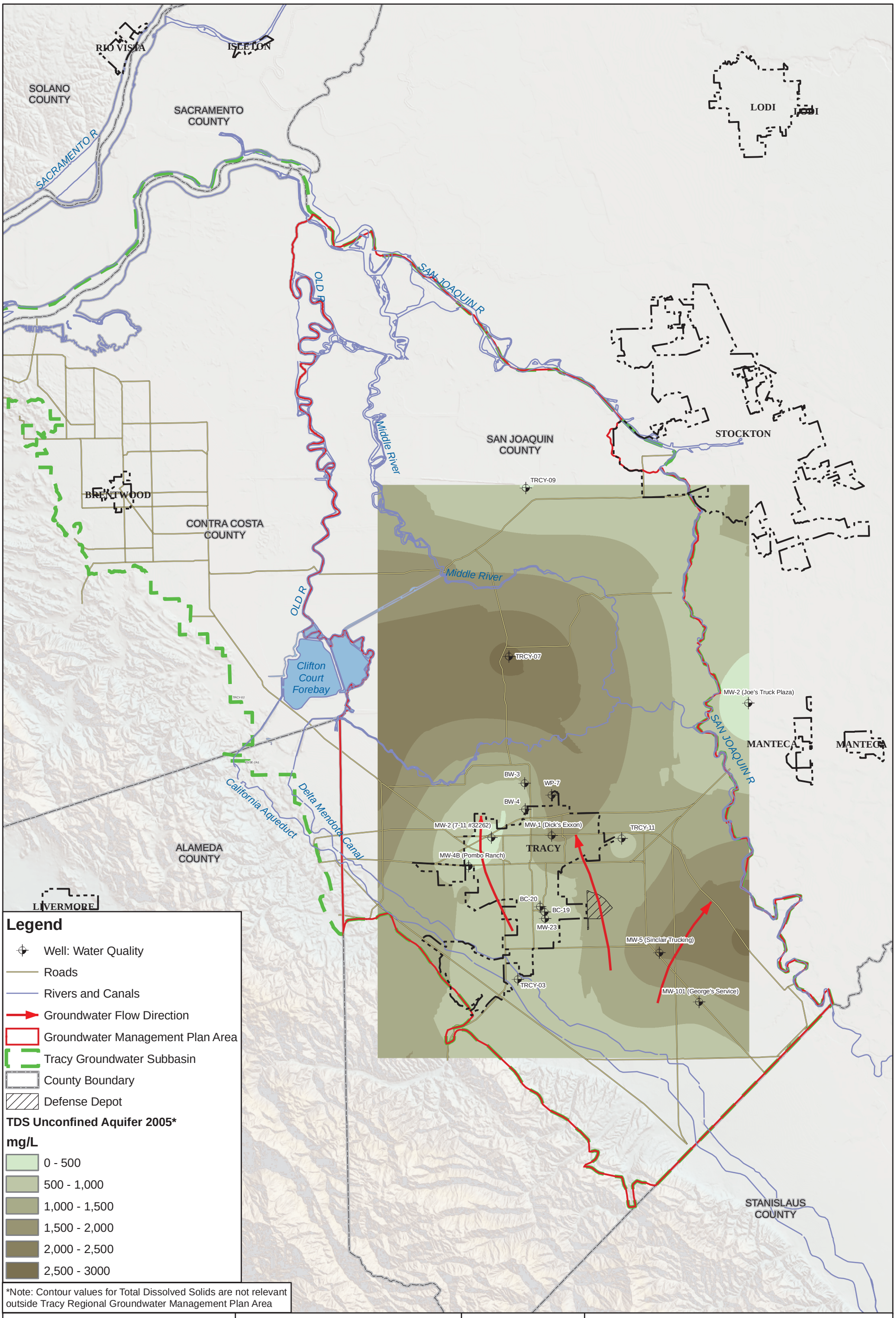
Unconfined Aquifer
Total Disolved Solids, 1968

JANUARY 2007

FIGURE 21

16-Jan-07 S:/GIS/Projects/060260/Tracy_TDS_unconf_1968_fig21.mxd



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San Joaquin County, California

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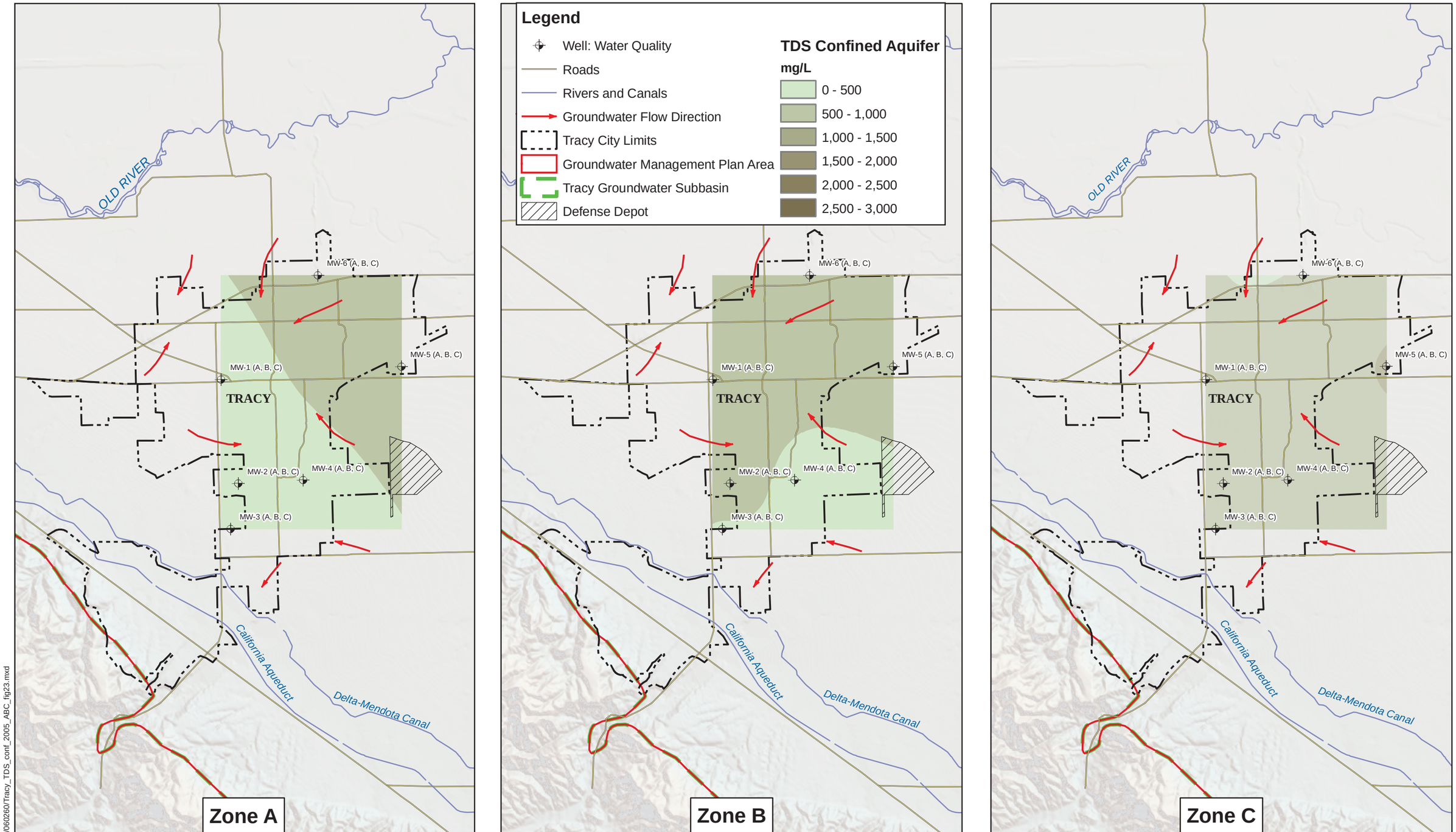
Unconfined Aquifer
Total Disolved Solids, 2005

JANUARY 2007

FIGURE 22

15-Jan-07 S:/GIS/Projects/060260/Tracy_TDS_unconf_fig_11x17.mxd



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San Joaquin County, California

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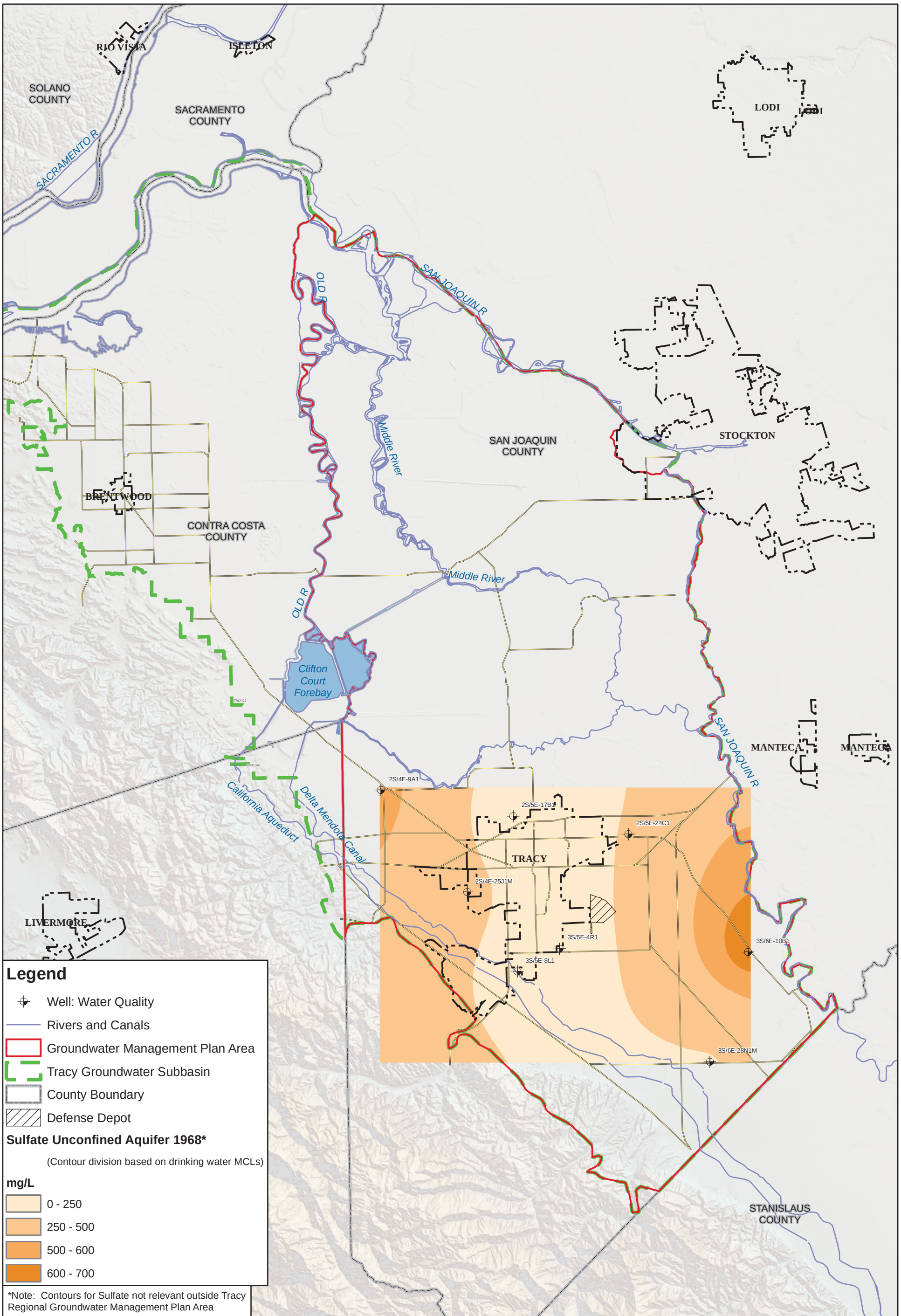
Bookman-Edmonston Division

CONFINED AQUIFER
TOTAL DISSOLVED SOLIDS, 2005
ZONES A, B AND C

JANUARY 2007

FIGURE 23

15-Jan-07 S:/GIS/Projects/060260/Tracy_TDS_conf_2005_ABC_fig23.mxd



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San Joaquin County, California

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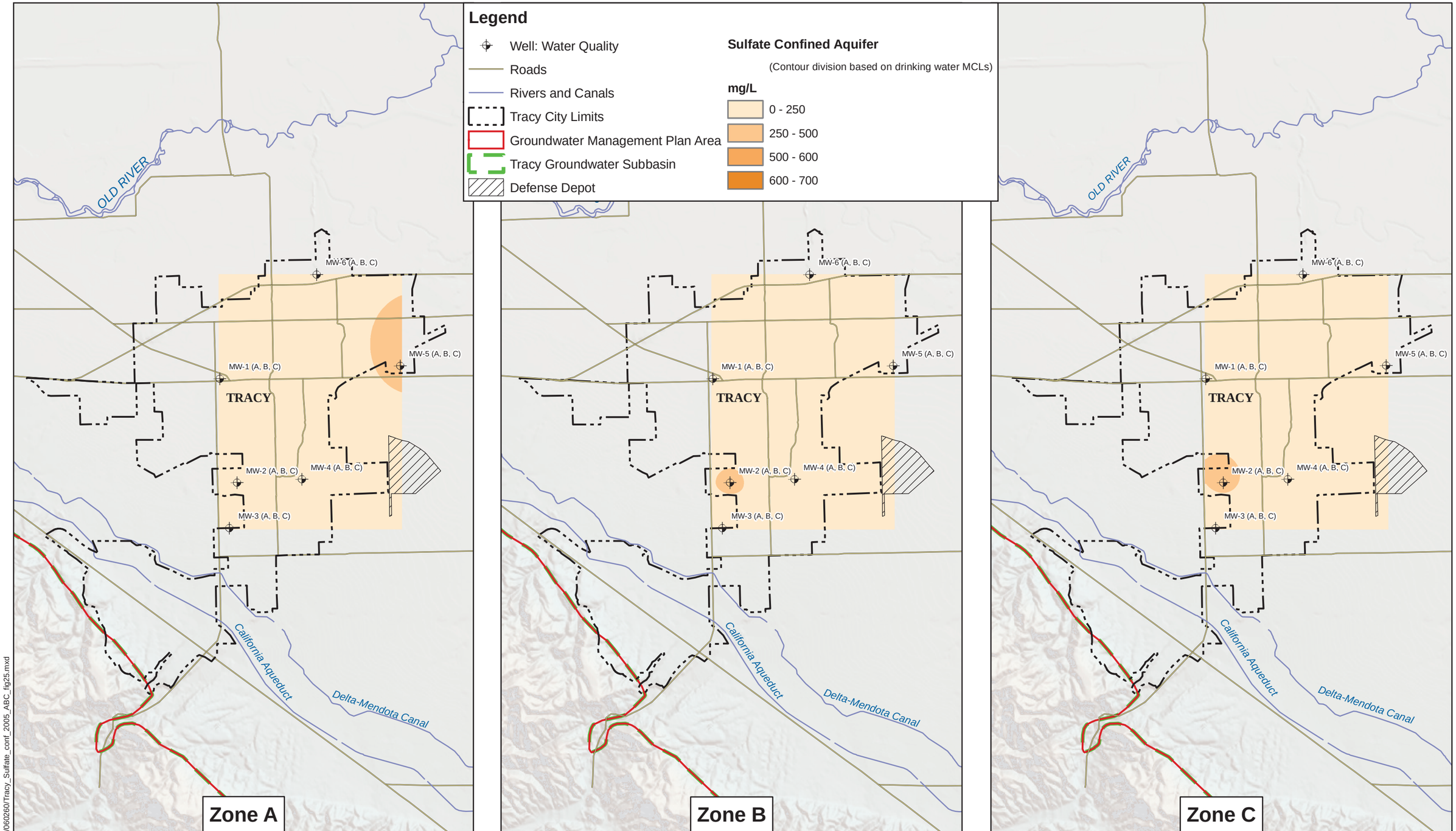
UNCONFINED AQUIFER SULFATE CONCENTRATIONS, 1968

JANUARY 2007

FIGURE 24

19-Jan-07 S:/GIS/Projects/060260/Tracy_SO4_unconf_1968_fig24.mxd



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San Joaquin County, California

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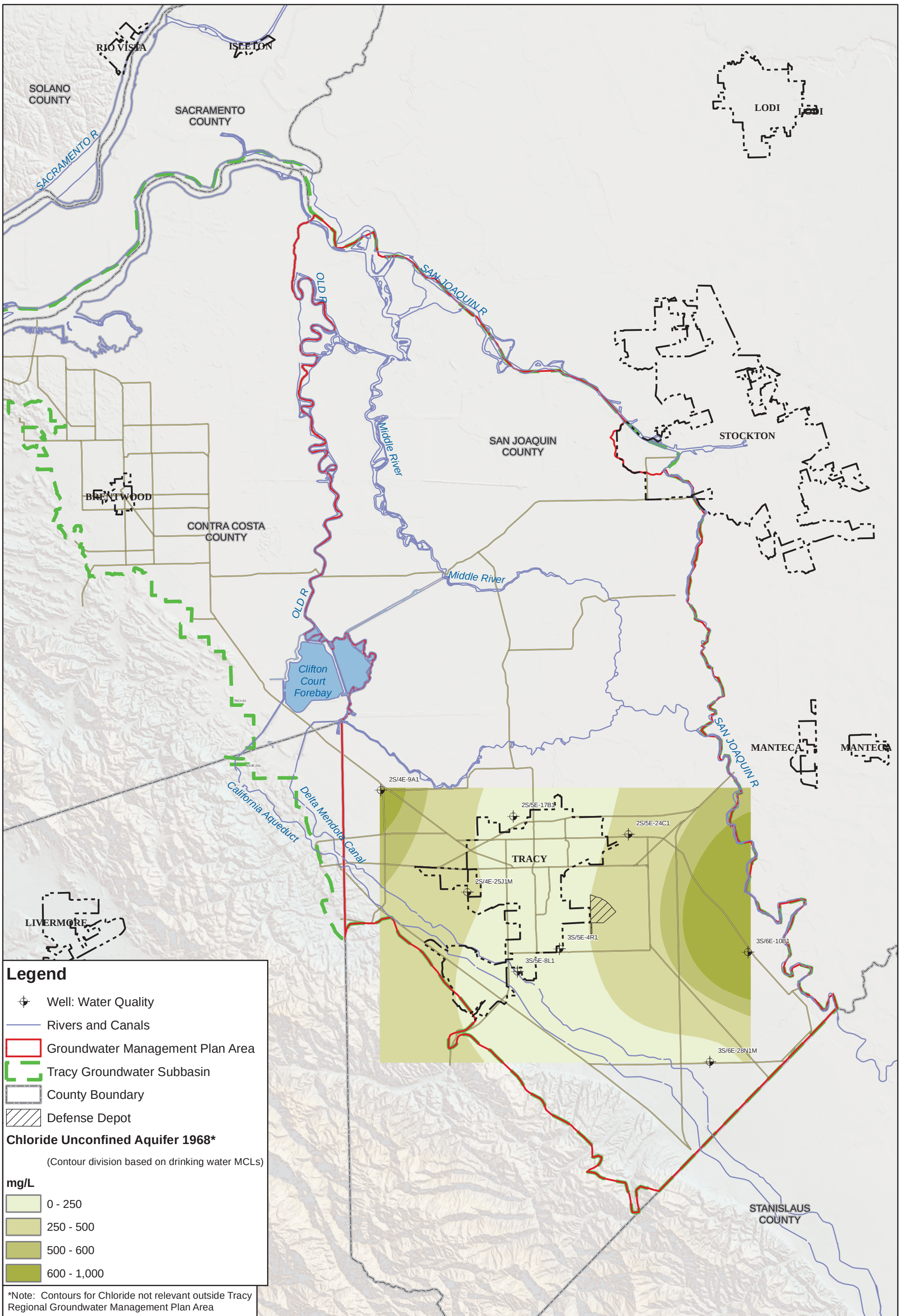
Bookman-Edmonston Division

CONFINED AQUIFER SULFATE, 2005
ZONES A, B AND C

JANUARY 2007

FIGURE 25

15-Jan-07 S:/GIS/Projects/060260/Tracy_Sulfate_cont_2005_ABC_fig25.mxd



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San Joaquin County, California

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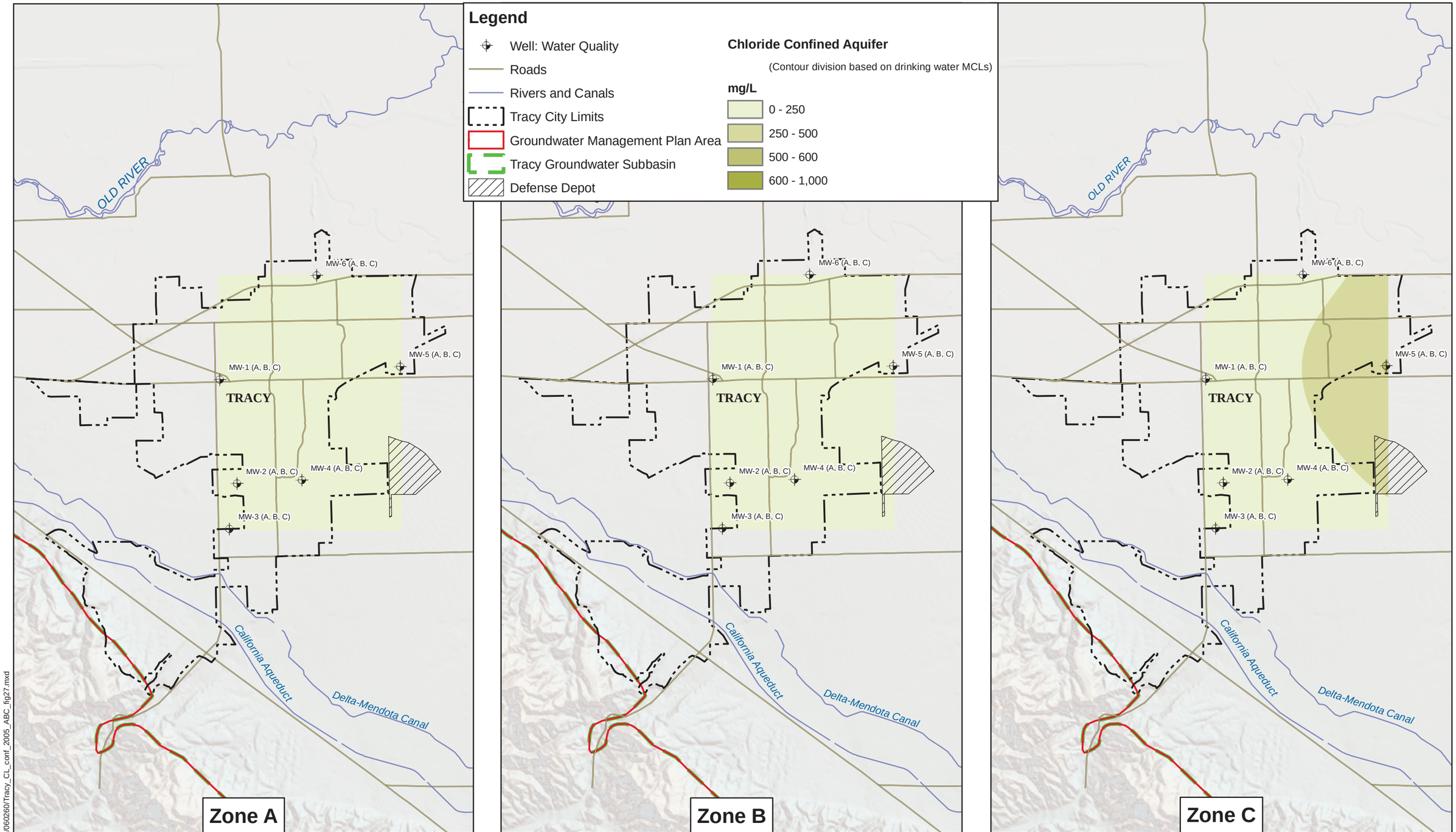
UNCONFINED AQUIFER CHLORIDE CONCENTRATIONS, 1968

JANUARY 2007

FIGURE 26

19-Jan-07 S:/GIS/Projects/060260/Tracy_CL_unconf_1968_fig26.mxd



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San Joaquin County, California

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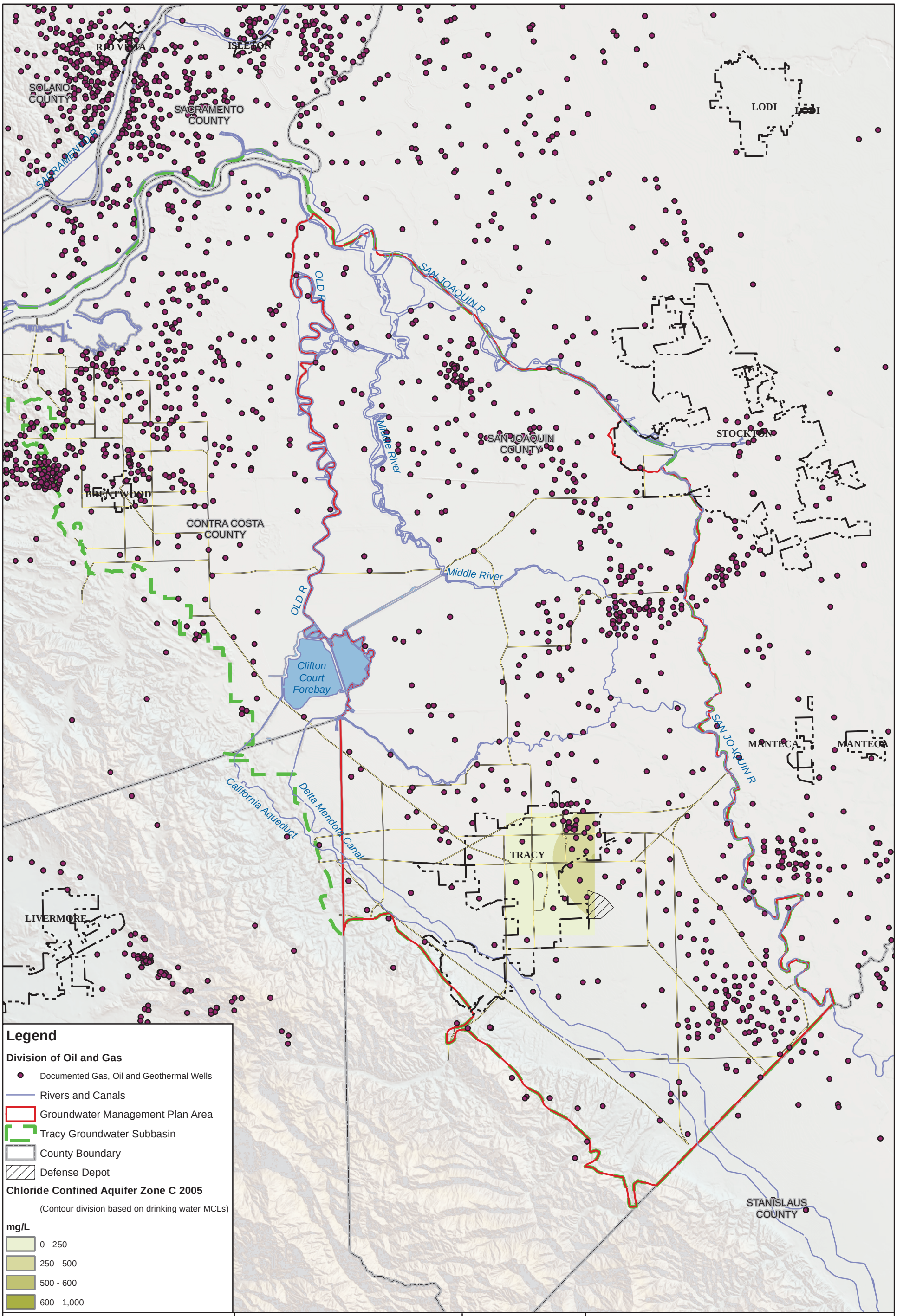
CONFINED AQUIFER CHLORIDE, 2005
ZONES A, B AND C

JANUARY 2007

FIGURE 27

19-Jan-07 S:/GIS/Projects/060260/Tracy_CL_cont_2005_ABC_fig27.mxd



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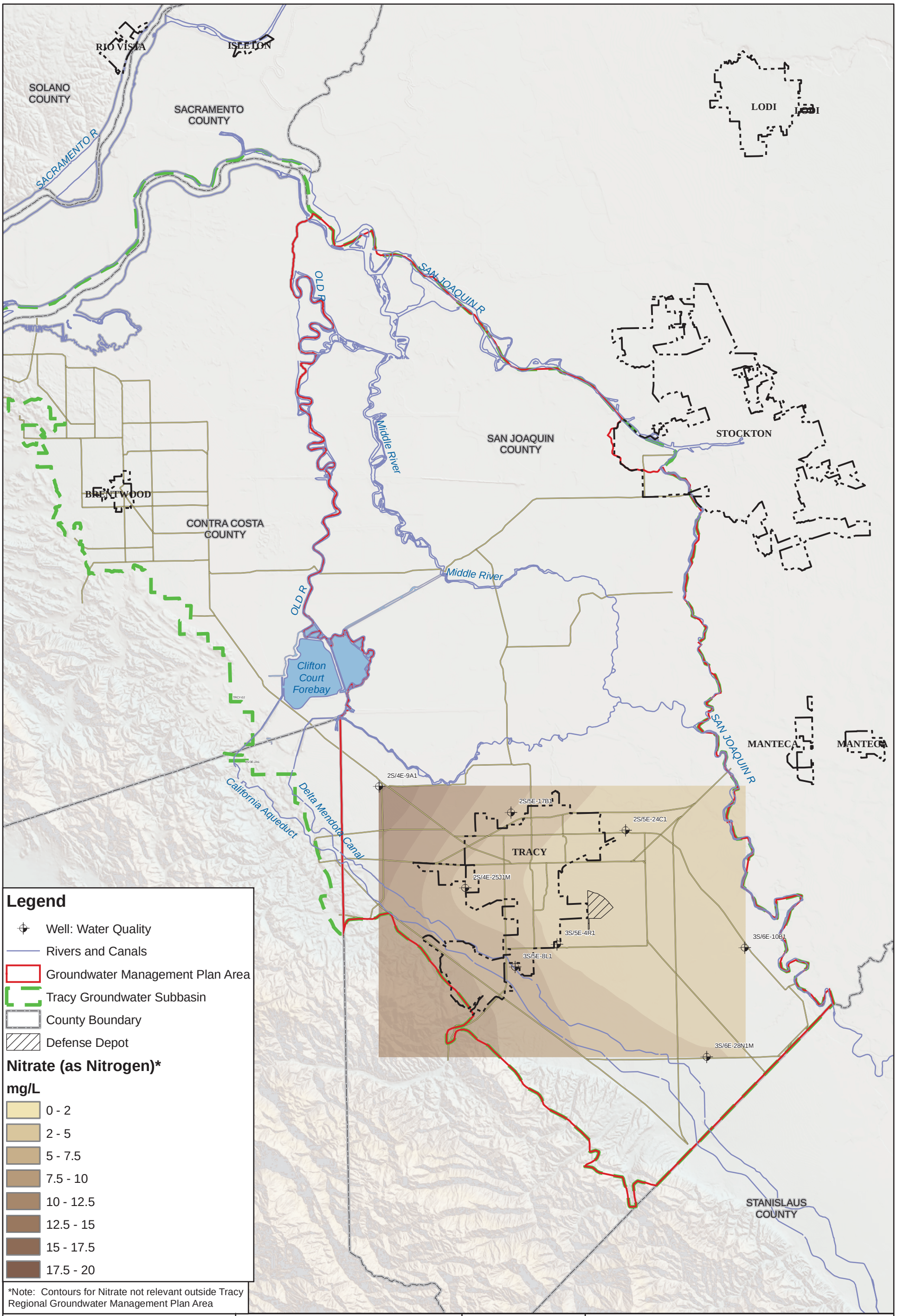
OIL AND GAS WELLS
WITH CONFINED AQUIFER CHLORIDE
CONCENTRATIONS, 2005, ZONE C

JANUARY 2007

FIGURE 28

19-Jan-07 S:/GIS/Projects/060260/Tracy_CL_conf_C 2005_DOGGR_fig28.mxd



Tracy Regional Groundwater Management Plan

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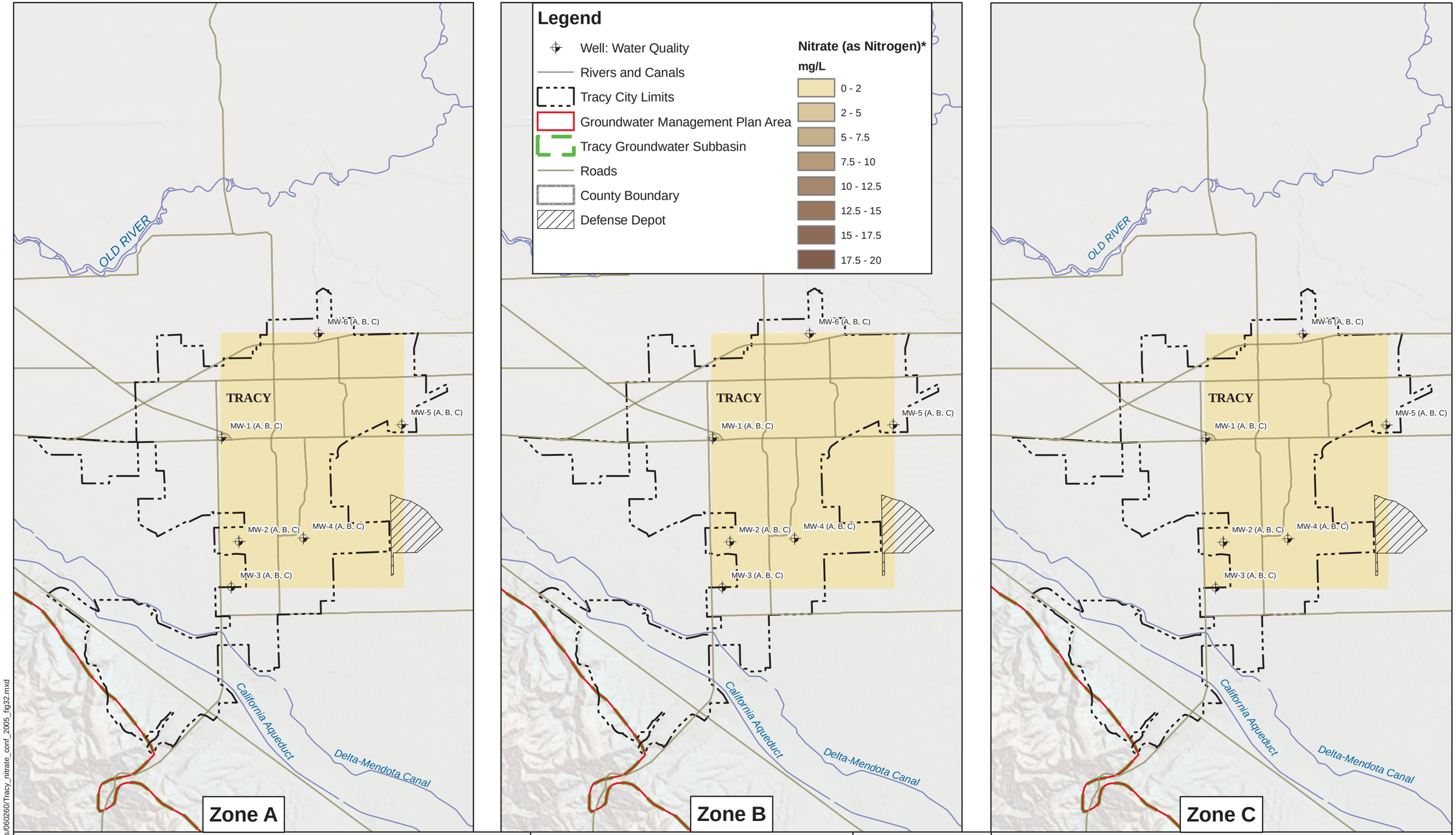
Unconfined Aquifer
Nitrate (As Nitogen) Concentrations, 1968

JANUARY 2007

FIGURE 29

15-Jan-07 S:/GIS/Projects/060260/Tracy_nitrate_unconf_1968_fig29.mxd



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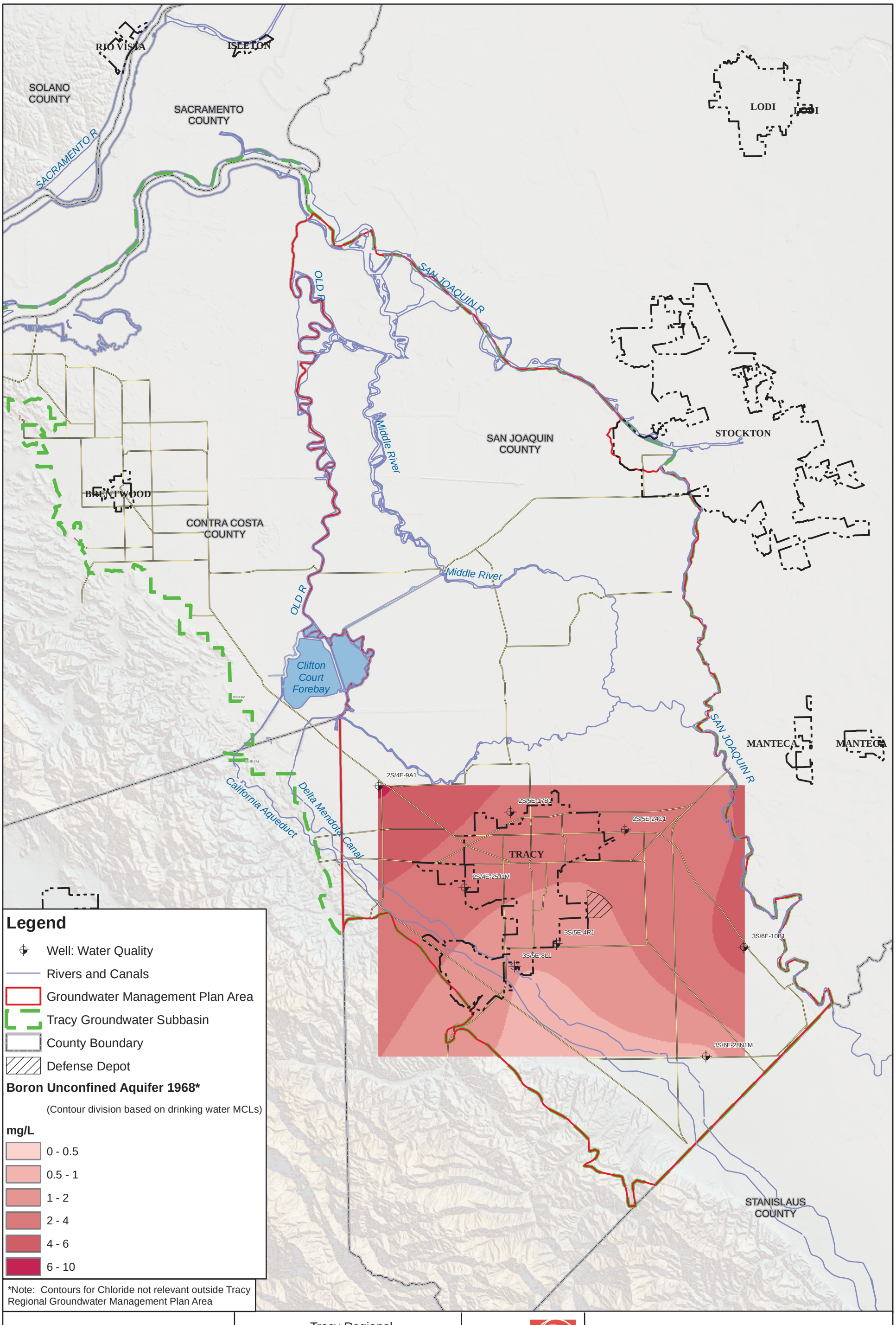
CONFINED AQUIFER NITRATE, 2005
ZONES A, B AND C

JANUARY 2007

FIGURE 30

16-Jan-07 S:/GIS/Projects/060260/Tracy_nitrate_conf_2005_fig32.mxd



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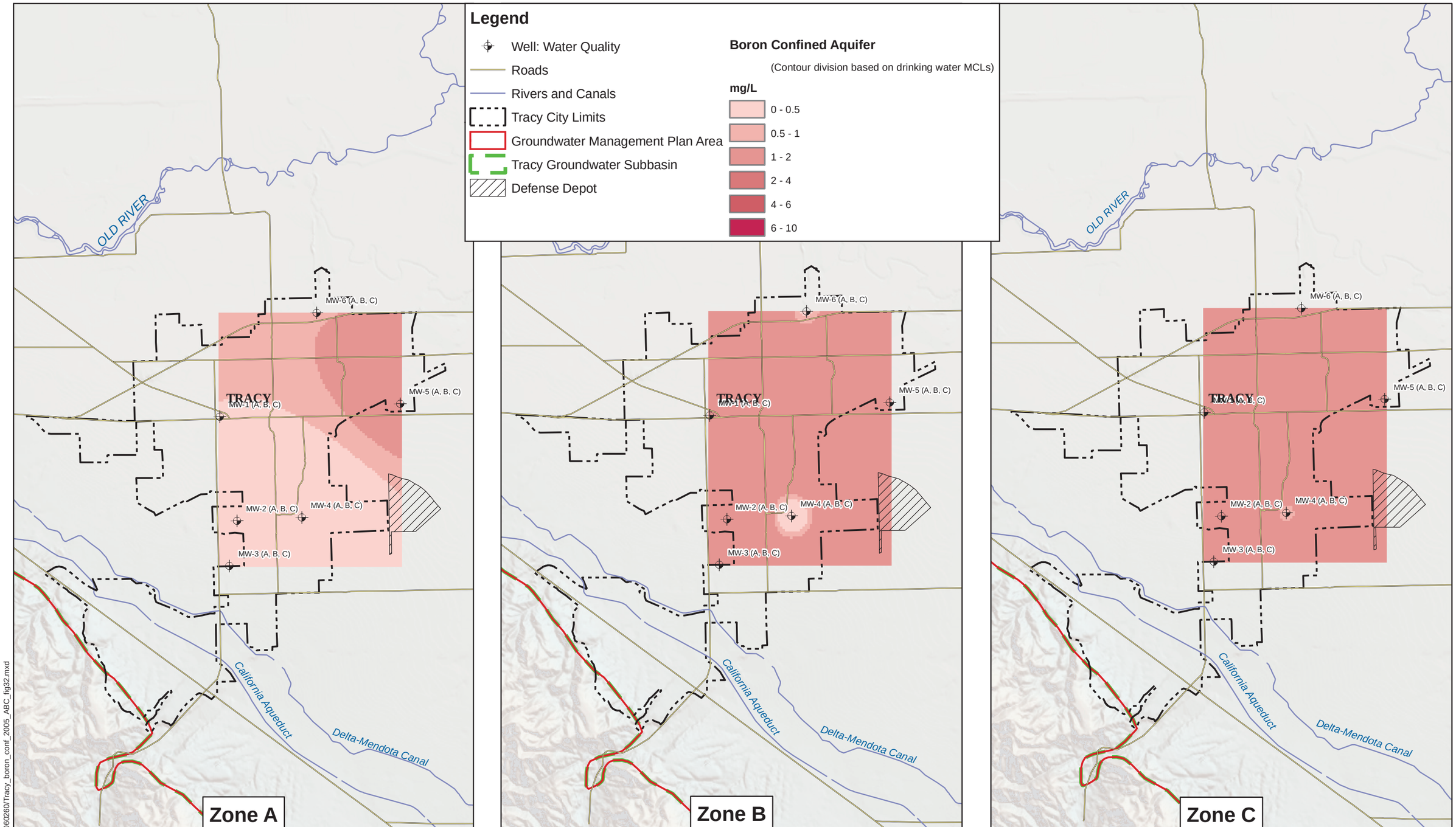
UNCONFINED AQUIFER BORON CONCENTRATIONS, 1968

JANUARY 2007

FIGURE 31

19-Jan-07 S:/GIS/Projects/060260/Tracy_boron_unconf_1968_fig31.mxd



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Tracy Regional
Groundwater Management Plan

San Joaquin County, California

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CONFINED AQUIFER BORON, 2005
ZONES A, B AND C

JANUARY 2007

FIGURE 32

19-Jan-07 S:/GIS/Projects/060260/Tracy_boron_conf_2005_ABC_fig32.mxd

FIGURE 33
TDS AND CHLORIDE TRENDS FOR MW-5C

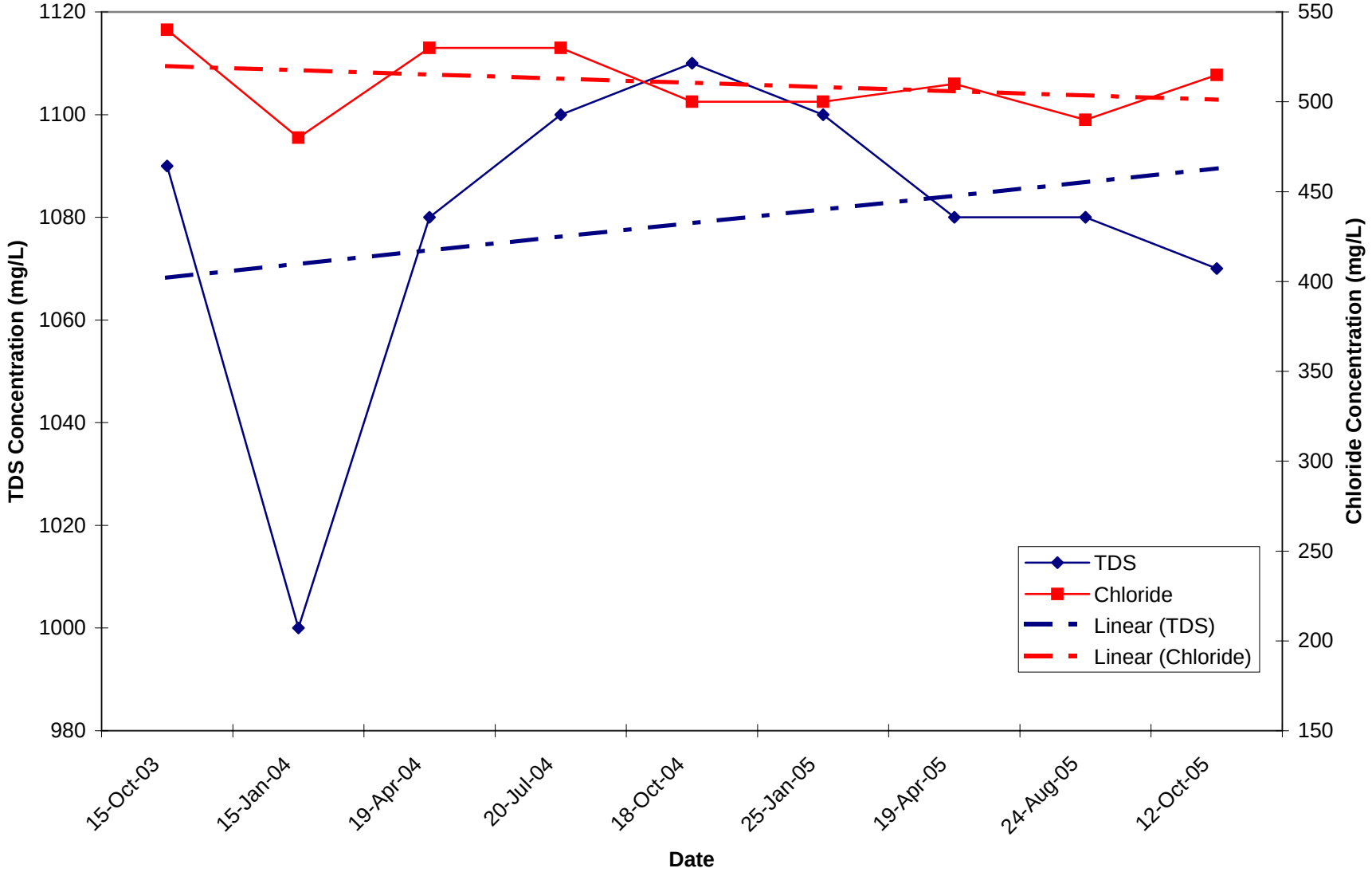
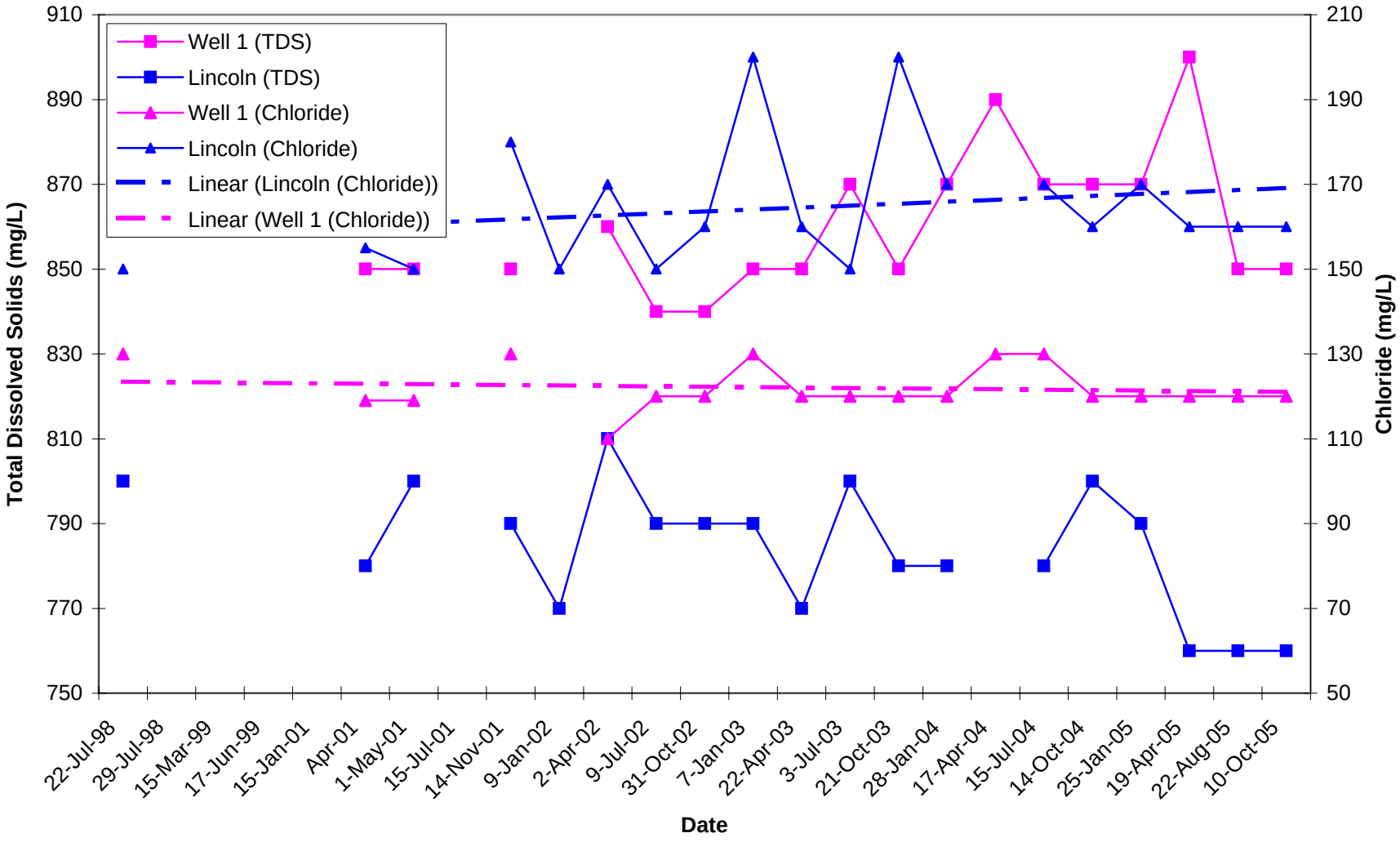


FIGURE 34
TDS AND CHLORIDE TRENDS FOR PRODUCTION WELLS



Appendix E

E. Groundwater Monitoring Plan

Groundwater Monitoring Plan

for the Tracy Subbasin

Submitted to:
City of Tracy, California

Date: March 2007
Project No: 060260

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5 Groundwater Monitoring Frequency
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1 Introduction

Bookman-Edmonston, a division of GEI Consultants (B-E/GEI), has prepared this Groundwater Monitoring Plan (GMP) for the Tracy Regional Groundwater Management Plan stakeholders to provide guidance for groundwater monitoring and sampling. The groundwater monitoring network and data acquisition will provide basic information needed to manage groundwater and surface water resources.

1.1 Location

The Tracy groundwater subbasin is located in the northern portion of the San Joaquin Valley groundwater basin. The Tracy subbasin overlies portions of San Joaquin and Contra Costa Counties. Nearby cities include Stockton and Lathrop to the northeast, with Discovery Bay and Antioch to the north. The City of Tracy (City) lies in the southern portion of the Tracy subbasin. The San Joaquin River and southern portion of the Sacramento River Delta border the north and east side of the study area, with the coast range bordering the southwestern portion of the subbasin. Figure 1 shows the location of the subbasin in relation to cities, rivers, other water bodies, and highways.

1.2 Goals and Objectives

The goal of this GMP is to develop the necessary tools and procedures for the subbasin stakeholders to manage their groundwater resources.

The objectives of this monitoring plan are to establish a groundwater monitoring network capable of collecting hydraulic measurements that will be used to characterize groundwater occurrence, flow direction, water quality, and recharge areas, and to provide a sound technical foundation for managing groundwater in the subbasin.

2 Monitoring Network

The following sections describe the rationale for the selection of monitoring points to be included in the monitoring network.

2.1 Rationale

Groundwater within the Tracy subbasin is influenced by groundwater pumping, subsurface inflow and outflow, recharge from deep percolation of irrigation water, and the rivers. Development of the monitoring network is intended to quantify the occurrence, level, quality, gradient, and relationships of each aquifer. It is possible that some of the aquifers may be locally interconnected. The following sections describe the rationale for selecting the monitoring network.

2.1.1 Geology

The subbasin is underlain by unconsolidated and consolidated sediments. In general, the geology consists of sediments eroded off the surrounding mountain ranges and at times have been transported the length of the San Joaquin Valley. The sediments are generally coarser-grained in the southwestern portion of the subbasin, having been deposited as coalescing alluvial fans and rivers from near the Coast Ranges, and finer-grained to the east.

The fresh water-bearing sediments beneath the subbasin, from youngest to oldest, are grouped into recent alluvium, older fanglomerate, and the Tulare Formation (CGS, 2005). Underlying the Tulare Formation are the San Joaquin clays, which are considered to be the base of the fresh water aquifer system (SDMG, 1943). The clays are present at a depth of about 900 feet below ground surface (bgs) near the City. Figure 2 shows the location of the geologic profiles developed to show the extent and relationship of the sediments in the subbasin. Figures 3 and 4 are two geologic profiles that illustrate the local subsurface geology.

Recent alluvium is generally found in the valley floor and along recent stream channels. The alluvium is generally thicker and finer grained in the valley and thins and is coarser towards the southwest as it approaches the Coast Ranges. In the valley, the sediments are associated with deposition from the San Joaquin and Sacramento Rivers and consist of sand layered with silt and clay. Figures 3 and 4 show the relationship of these sand layers to the current San Joaquin and Sacramento Rivers. The rivers in the western portion of the subbasin intersect some of the sand layers. The sand appears to be relic river channels that meander and typically trend toward the west. Near the Coast Ranges, the coarser sediments have more of a northerly trend.

Underlying the recent alluvium is the Tulare Formation and an older fanglomerate. The Tulare Formation is subdivided into an upper and lower portion that is separated by a thick regional clay bed known as the Corcoran clay. The upper portions of the Tulare Formation, along the southern margins of the subbasin, consist of fine to coarse-grained floodplain, fan, and terrace deposits. The fan sediments consist of angular gravels mixed with sand, clay, and silt and are thicker near the southwestern margin of the subbasin and thin toward the center of the valley. In the central portions of the subbasin, the upper formation consists of clay, silt, and sand. Well drillers typically do not identify the change from the recent alluvium to the Tulare Formation.

The Corcoran clay formed in a large lake that extended from the Bakersfield area north to Tracy and is found mostly beneath the western half of the San Joaquin Valley. The Corcoran clay extends to just east of the San Joaquin River and to the west to Antioch. The clay is about 60 to 100 feet thick in the Tracy subbasin. Near the Tracy airport (Production Well 2), the clay contains some gravel. It is possible that these sand and gravel beds (fanglomerates) interfinger with the Corcoran clay and may entirely replace the clay near the southern edge of the subbasin. Figures 3 and 4 show the extent and structure of the Corcoran clay based on geologic profiles and geophysical logs.

The lower portion of the Tulare Formation is typically coarser than the upper portion of the formation. The sediments consist of sand and gravel beds that are interbedded with clays and silt. The coarse sediments are more prevalent in the western and southern portions of the subbasin.

The relationship of the older fanglomerate and the Tulare Formation is unclear, based on the drillers well logs. Either the Tulare Formation rests on the fanglomerate or the fanglomerate is actually part of the Tulare Formation. In some locations, the Corcoran clay appears to extend into the fanglomerate. In either case, the fanglomerate gravels are a potential conduit to convey water below the Corcoran clay.

The Tulare Formation, in the central portion of the subbasin, rests on the San Joaquin clay. Although the San Joaquin clay was not fully penetrated, it is at least 400 feet thick.

2.1.2 Aquifers

Sand and gravel beds are generally grouped together to form aquifers that may display similar characteristics. The aquifers are separated by single or multiple clay layers (or aquitards) that can slow or prevent vertical movement of groundwater between aquifers. There are two principal aquifers in the subbasin that are separated by the Corcoran clay. The Corcoran clay acts as a regional low permeability layer that limits vertical movement of groundwater.

Above the Corcoran clay are unconfined to semi-confined aquifers. The groundwater is not compressed and results in a water surface that is at atmospheric pressure or a water table

aquifer. These aquifers are roughly 80 to 300 feet thick within the groundwater management plan area. The unconfined and semi-confined aquifers are in the recent alluvium and in the upper portions of the Tulare Formation.

Below the Corcoran clay, the aquifers are confined. In a confined aquifer, the groundwater is under pressure. When a confining bed is penetrated, the water level rises above the bed and could result in artesian flowing wells. These confined aquifers in the subbasin are up to 500 feet thick and are present in the lower portions of the Tulare Formation.

In the southwestern portion of the subbasin, where the fanglomerates may have replaced the Corcoran clay, the unconfined and confined aquifers may be connected. The unconfined and confined aquifers also join outside of the subbasin to the east. The Corcoran clay ends somewhere west of the San Joaquin River. Figure 4 shows the aquifers merging to the east. The unconfined aquifer recharges the confined aquifer in those areas where the Corcoran clay is absent.

2.1.3 Groundwater Quality

Groundwater in the Tracy subbasin is variable with some localized areas of good quality water. For the most part, good quality water is present in both the confined and unconfined aquifers near the southwestern margin of the subbasin. In the remaining portions of the subbasin the groundwater is marginal to poor and could move into the areas of good quality water. Problem constituents (constituents of concern) include total dissolved solids (TDS), nitrates, boron, chloride, and sulfate. In addition to these constituents, localized areas of manmade contamination, including trihalomethanes, volatile organic compounds (solvents), and gasoline are present.

2.2 Monitoring Network

The most desirable wells to be included in the monitoring network are wells with short screen intervals completed within a single aquifer system. However, some wells with longer screen intervals may need to be included initially in the network to provide regional representation of the groundwater level and water quality. Data obtained from the longer screen wells usually represent an aggregate of water quality from two or more aquifers. These wells with longer screen intervals should be replaced with wells with shorter screen intervals to improve the monitoring network.

The monitoring network consists of wells owned by the City of Tracy, Department of Water Resources (DWR), and private parties. Combined, the network will provide the necessary data to assess groundwater conditions beneath the Tracy subbasin. Monitoring will be performed by multiple parties, but the data will be collected by the City of Tracy. Table 1 and Table 2 identify groundwater wells selected for groundwater monitoring. These tables also provide well construction details and the aquifer monitored. Figure 5 shows the location of these wells.

DWR monitors groundwater levels semiannually in spring (February to April) and fall (October to November). The City of Tracy also monitors several properties where releases of contaminants have affected groundwater and are required to monitor groundwater levels and quality on a quarterly basis.

In summary, the groundwater monitoring network will consist of wells designated for groundwater level, quality, and/or production monitoring. These wells are divided between the unconfined aquifer and confined aquifer as follows:

- Unconfined Aquifer: 24 wells
- Confined Aquifer: 18 wells

If at any time in the future potentially important wells are discovered or constructed, the monitoring program should be updated to include such wells. Should additional wells become available, the list above and Table 1 should be revised. There are municipal, irrigation, production and remediation wells in the area that extract groundwater from the aquifers. These wells extract from the unconfined, confined, or both aquifers. Extraction of groundwater from the Tracy subbasin should be tracked to further assess groundwater movements and quality. Table 3 shows the details of production wells. In addition to groundwater monitoring, the monitoring network will include stations to measure whether the ground surface is changing.

Subsidence, a general term used when the ground-surface-elevation permanently decreases, may occur as a result of groundwater extraction, compaction of soils, or decomposition of peat deposits. The subsidence monitoring network currently consists of seven benchmarks around the City that will be surveyed annually. Table 4 lists the benchmark locations. Figure 5 shows their locations.

3 Monitoring and Reporting Frequency

The following sections describe the frequency for monitoring and reporting. The monitoring frequency is summarized on Table 4. Subsequent sections provide a description of the work to be accomplished during each of the designated monitoring periods. Specific methods and procedures are described in Sections 5 through 9.

3.1 Groundwater Pumping

Irrigation and municipal users pump significant amounts of groundwater from the subbasin. Tracking the groundwater pumping provides a reason why groundwater levels may be lower in some areas and potentially the cause of migration of poorer quality water. Groundwater pumping from those wells listed on Table 3 should be recorded on a monthly basis. Figure 6 shows the location of these wells.

3.2 Groundwater Level and Conductivity Monitoring

Groundwater levels from all wells listed in Tables 1 and 2 shall be measured in March, July, August, and October. If possible, the City should coordinate with other participating agencies to make groundwater level measurements on the same day, but at no time should the measurements be taken exceeding a one-week period.

3.3 Water Quality Monitoring

Water quality samples will be collected from the monitoring wells for a more extensive analysis of the water chemistry. The monitoring wells will be sampled on a quarterly basis, concurrent with the groundwater level and conductivity measurements.

The water quality analysis provides an indication of the source of the water, changes over time, and potential mixing between aquifers. The results will be used to assess the effects of groundwater management actions. The samples will be analyzed for TDS, nitrate, chloride, sulfate, and boron. After the completion of two years of water quality monitoring, the monitoring program will be reviewed and revised as necessary to alter the monitoring frequency or add or eliminate constituents from the program.

3.4 Subsidence

In the spring of each year, a licensed California land surveyor will survey each of the seven benchmarks within the City. The data from these surveys shall be archived in a database for future analysis.

3.5 Reporting

The City will prepare an annual monitoring report to summarize the findings of the groundwater level, production, water quality, and subsidence data. The report should include an interpretation of the data, including but not limited to groundwater flow directions, relationship of pumping to water quality, water levels, land subsidence, a discussion of any significant changes from the last reporting period, and groundwater management recommendations. Recommendations should also be provided to improve the monitoring network.

4 Project Organization and Responsibility

The designated contact for making decisions regarding the City's GMP is Deputy Director of Public Works Steven G. Bayley (Deputy Director). The City will plan, organize, collect, and archive the groundwater monitoring and sampling data. The following is a summary of the monitoring, sampling, and reporting responsibilities under this GMP.

The City's personnel are responsible for the following:

- Coordinating monitoring and sampling schedules so that all activities scheduled for a particular month occur within the same week.
- Scheduling equipment and supplies needed for sampling and monitoring.
- Measuring and recording groundwater levels.
- Measuring and recording electric conductivity measurements.
- Arranging with the laboratory for sample bottles and analysis.
- Collecting representative groundwater samples.
- Archiving sampling and monitoring results.
- Oversight of quality assurance/quality control (QA/QC) sampling and monitoring methods and procedures.
- Revising this GMP on an annual basis, as necessary.
- Preparing an annual summary report of the sampling and monitoring results for the Tracy Regional Groundwater Management Plan stakeholders and the public.

State-certified laboratories, used for water quality analysis, will be responsible for sample analysis quality control and assurance. The laboratory shall notify the Owner immediately if samples have been compromised during shipment or handling or if the requested analyses cannot be conducted within the designated holding times. The owner shall either attempt to collect additional samples for analysis or convey to the City that the sample analysis is not valid.

5 Groundwater Pumping

Groundwater pumping from production and irrigation wells listed on Table 3 should be measured monthly to show why groundwater levels may be locally declining and potential causes for changes in water quality. Table 4 summarizes the groundwater pumping well monitoring schedule for the GMP. The measurements should be made within the same week.

5.1 Preparation for Field Work

Field personnel shall prepare for field work by obtaining the following equipment:

- A copy of Table 5 to record the field measurements
- Figure 5 showing the location of the wells
- Clipboard and ballpoint pen

5.2 Meter Reading

The large agricultural and municipal wells should be equipped with totalizing flow meters. The totalizer reading shall be recorded onto Table 6 to provide consistency in the measurements. Field measurements should include all numbers displayed on the meter, including zeros, which provides a level of quality control that the meter was read correctly. Also, the units of each meter should be documented. Any issues associated with the meter, including ability to read the meter, or suggested maintenance shall also be documented.

5.3 Quality Assurance

After recording the totalizer readings, the stakeholder should enter the data into an electronic accounting form that will automatically subtract the measurement from the previous month's reading (electronic copy of the accounting form available through B-E/GEI). Each stakeholder's manager should review the production data for accuracy within five days of obtaining the initial measurement. Should a measurement appear suspicious, a confirmation reading shall be obtained. Personnel should be prepared to maintain and calibrate the flow meters.

6 Groundwater Level and Conductivity Monitoring

Groundwater levels and electrical conductivity (EC) shall be measured in all wells designated for groundwater level monitoring (Tables 1 and 2) in March, July, August, and October. Table 5 summarizes the monitoring schedule for the GMP. If possible, City personnel should arrange with the stakeholders to make groundwater level measurements on the same day, but at no time should the measurements be taken after a one-week period.

6.1 Preparation for Field Work

Prior to collecting groundwater level and conductivity measurements and before going to the field, sampling personnel shall clean, maintain, and test the water level sounder and calibrate the EC meter using appropriate standards.

The sampling personnel will assemble the following equipment and supplies:

- Copy of Table 6, Field Form for Water Level and Electrical Conductivity Measurements
- Copy of Figure 5, Monitoring Network Location map
- Portable electrical conductivity meter, calibration standards, and manufacturer's calibration instructions
- Electrical water level sounder
- Ballpoint pen and clipboard
- Paper towels
- Bleach
- Spray bottles
- Distilled water

6.2 Calibration of Field Equipment

Prior to collecting groundwater level and conductivity measurements and before going to the field, sampling personnel shall clean, maintain, and test the water level sounder and calibrate the EC meter using appropriate standards.

6.2.1 Electrical Conductivity Meter

The frequency and nature of the EC meter calibration shall be consistent with the manufacturer's recommendations. At a minimum, the meters shall be calibrated every day and when significant changes in climatic conditions occur (e.g., when the air temperature changes by more than 10°F).

The meter type, its manufacturer, model and identification numbers, and calibration information shall be documented in the files.

6.2.2 Groundwater Level Sounder

During use of a water level sounder, it is possible for the cable to become stretched or shortened because of tangles and obstructions in wells. The water level sounder shall be laid out and compared with a steel tape and the results documented annually. When calibration measurements show that the measurements are greater than 0.10 feet off in 100 feet, the cable shall be replaced.

6.3 Monitoring Procedures

The following procedures shall be used to measure the depth to water and EC at each designated monitoring well. Water levels and EC measurements will be collected to assess the groundwater flow direction and quality to develop trends that can lead to improved management of the groundwater resources.

6.3.1 Groundwater Level Measurements

Prior to obtaining the water level measurement at each well and between each well site, the bottom 10 feet of the electric sounder cable shall be rinsed in a solution of sodium hypochlorite (liquid bleach) and distilled water. The solution shall consist of bleach and distilled water in a one-tablespoon-to-one-quart ratio (a concentration of about 200 parts per million chlorine is desirable). The sounder shall then be rinsed thoroughly three times with distilled water and allowed to air-dry. Thorough cleaning of equipment is necessary to avoid any possibility of cross-contamination and transport of bacteria between wells.

Each well has been assigned a unique identification number and a common name. The numbers and names for each well to be monitored are listed on Tables 1 and 2. The Groundwater Level Sampling and Purging Form (Table 7) will be used to record all groundwater level measurements.

Prior to purging and sampling, the depth to static groundwater level will be obtained at each well using an electric water level sounder with a cable graduated in increments of 0.01 foot.

Static groundwater levels are measured at the production wells when they are not being pumped and if they have been idle for 24 hours. At times, when a production well cannot be

taken out of service, water levels are not measured. The production wells typically have screen lengths of 100 feet or more and are often screened opposite multiple aquifers. Therefore, groundwater level data from these wells represent an aggregate of several aquifers and may not be representative of an individual aquifer's condition. Thus, an interpretation of groundwater level data from production wells must be used cautiously and should be used only to specify general rather than actual conditions of the aquifers at a particular well location. Tables 1 and 2 summarize the construction details for each of these production wells.

To obtain a depth to water measurement, the electric sounder cable will be lowered slowly into the well through the access port until the sounder indicates submergence by either a beeping sound or light, depending on the type of signal installed for that particular model. At this point, the sampling personnel will note the depth to water (to the nearest 0.01 foot) from the reference point. The depth shall be confirmed by lifting the sounder above the water surface by about 2 to 3 feet and then re-measuring the depth to water. If the depth remains constant, the depth-to-water shall be recorded on Table 7, along with the time and date of the measurement. If the depth changes, the sampling personnel shall indicate that on the form, as well as the variable nature of the measurement and its possible cause (e.g., bouncing, recovering water levels, oil on water surface).

6.3.2 Electrical Conductivity Measurement

A representative sample of the groundwater must be obtained from the well. A "representative" sample is water that has recently been in the aquifer and is obtained by pumping the well. There are several methods that can be used to obtain representative samples. Generally, water quality samples obtained near sites with groundwater contamination use low flow purge techniques that limit the amount of water pumped from the well. Regulatory agencies typically approve of these procedures and they should continue to be used. The City also uses these techniques to purge water from their monitoring wells. For most irrigation and municipal wells, where large pumps are present and disposal of water is not an issue, a "representative" sample can be collected when at least three well volumes have been pumped from the well. Approximate purge times can be calculated by using Table 7. The purge times may also be calculated using an electronic spreadsheet available from B-E/GEI upon request.

There are several different types of EC meters that may be used by the City. Some have a sample cup that is built into the unit, while others have a probe that requires a sample be collected in a separate container.

Sampling personnel will collect water from as close to the well as possible and place the sample in the EC meter sample cup or container. The sample shall be poured into the meter sample cup or container, then discharged and replaced three times before taking a

measurement. The measurement shall be recorded on Table 4 and the sampling location noted (i.e., hose bib, end of discharge pipe, etc.).

After completing the measurement, the EC meter sample cup or probe and container shall be rinsed at least three times with distilled water to maintain the equipment and to prevent false readings in subsequent wells.

6.4 Quality Assurance

After field personnel have completed their work, they shall enter the data into an electronic spreadsheet or database. The managers shall review groundwater level and EC measurements for accuracy within five days of obtaining the measurements. Should a measurement appear suspicious, a confirmation reading shall be obtained.

7 Water Quality Monitoring

Water quality samples will be collected from the stakeholder wells listed on Table 2 and sent to a laboratory for a more extensive analysis of the water chemistry. The monitoring wells will be sampled on an annual basis, concurrent with groundwater level and conductivity measurements in July of each year. Table 5 summarizes the monitoring schedule.

The results will be used to assess the effects of groundwater management actions. The work described below will be performed concurrently with the July sampling events described in Section 6, Groundwater Level and Conductivity Monitoring. The first water quality sampling event should be scheduled for 2007.

7.1 Preparation for Field Work

Prior to water quality sampling, designated sampling personnel shall notify the laboratory about one week prior to when sampling is scheduled, list the sample analysis parameters, and request sample bottles. A copy of Table 8 and Section 8.0, Laboratory Procedures and Reporting of Results, should be faxed to the laboratory to confirm the analytical methods and analytical quality control and assurance requirements. Also the laboratory will be provided with the number of wells to be sampled so that they can provide the appropriate number of sample bottles. The laboratory should be requested to deliver sample containers in clean ice chests to the location chosen by the sampling personnel at least two days before the sampling begins. Upon receipt of the sample bottles, sampling personnel shall inventory the bottles to ensure that an adequate number and proper types of bottles have been provided.

The sampling personnel will assemble the following field forms, sampling equipment, and supplies:

- Copy of Tables 1 and 2, Monitoring Well Construction Details
- Copy of Table 7, Groundwater Level, Sampling and Purge Volume Form
- Copy of Table 9, Chain-of-Custody, or obtain one from the laboratory
- Sample bottles and ice chest from the laboratory
- Ballpoint pen and waterproof marking pen
- Safety glasses or goggles
- Latex or nitrile gloves

- Paper towels
- Ice

7.2 Sample Containers

Sample containers will be prepared by the laboratory with both preservative and container type in accordance with the required analysis as presented in Table 8. The containers shall be laboratory-cleaned prior to use, based on the analytes of interest, in accordance with the latest edition of the U.S. Environmental Protection Agency (USEPA) Standard Methods for Examination of Water and Wastewater. Sample containers must be stored in a fashion that prevents the accumulation of dust or other contaminants. Prior to shipment to the City's sampling personnel, the laboratory will be responsible for verifying the cleanliness and integrity of the sample containers pursuant to its sample container quality assurance and quality control procedures.

Each container will have a preprinted identification label that clearly shows the constituent(s) to be analyzed. A laboratory sample number will be assigned by the laboratory upon delivery of the sample(s) to the laboratory for proper identification and tracking.

7.3 Well Purging and Discharge

The water quality samples shall be collected after purging the well as described in Section 6.0. The well purge volumes used for Section 6 can be calculated by using Table 7. It is important to confirm that the purge volumes are sufficient for either low-flow sampling or to exchange three well volumes.

7.4 Sample Identification and Labeling

Each well has been assigned a unique identification number as listed in Tables 1 and 2. This number shall be marked on each sample bottle.

All sample containers will be pre-labeled, to the extent possible, prior to each sampling event to facilitate sampling activities. Sample containers provided by the laboratory will contain waterproof labels that will show the analyte and laboratory identification number. To the extent possible, the designated sampling personnel will inscribe the sample identification, name or initials of sampler(s), and date on the labels under dry conditions, using a waterproof marker pen during purging of each well. Immediately prior to collection of water samples, sampling personnel will inscribe on the sample bottle label the time the sample was collected.

7.5 Sample Collection

Groundwater samples shall be collected from the well discharge water as close to the pump as possible. The sampling location should be the same as that used to collect the EC measurements. Sampling personnel will be trained in the use of and exercise care during the handling of acid-preserved sample containers to minimize spillage, damage, and/or injury to the sampler(s) or the field equipment. In addition to latex or nitrile sampling gloves, the designated sampling personnel should wear safety glasses or goggles to minimize potential eye injury.

Designated sampling personnel will use “clean sampling techniques” to minimize potential contamination of water samples. Prior to the collection of samples, sampling personnel will rinse their hands and don sterilized latex or nitrile gloves. Sample containers and lids will not touch the ground, the sampling personnel’s clothing, or any other potential sources of contamination. Sample container lids will not be removed from a particular container until that container is to be filled. Sample containers shall be rinsed three times prior to collection of the sample unless the container contains a preservative. The sample container shall be filled to the top of the rim to minimize air space between the liquid level and the lid. The lid shall be tightened securely to the container immediately after sample collection is completed.

7.6 Sample Preservation and Storage

Chemical preservatives and refrigeration shall be used to maintain sample integrity prior to analysis. Immediately after the sample has been collected, it shall be placed in a clean ice chest containing commercially prepared ice packs to maintain the temperature in the ice chest between 2°C and 6°C until the samples have been delivered to the laboratory. The ice packs will be double-bagged to prevent ice-melt water from touching the sample containers. Samples must be returned to the laboratory within 24 hours of sampling to meet analytical holding time requirements.

7.7 Record Keeping and Chain-of-Custody

Sampling personnel will maintain Table 7 field forms showing the dates and times of sample collections. A chain-of-custody form indicating the sampling site, sampler's name, date and time sampled, and any special observations shall be filled out by sampling personnel and placed in a sealable plastic bag with the sample(s) in the ice chest. The samples shall remain in the control and custody of a designated sampling team member at all times. A chain-of-custody form is presented in Table 9. When sampling personnel deliver the samples to the laboratory, the laboratory will sign for custody of the samples and provide a copy of the completed chain-of-custody form to the sampling personnel.

7.8 Quality Control Samples

This sampling plan does not require collection of any field quality control samples because the parameters being collected are stable.

7.9 Quality Assurance

Within one day after field personnel have completed their work, the Managers shall review Tables 7 and 9 to assess if all of the necessary field information has been documented and that adequate purge times were allowed before collecting the samples. Upon receipt of the laboratory analyses, the Managers shall compare the results to historic data and identify any anomalous results and, if present, notify the laboratory to confirm the measurement. The information shall then be transmitted to the City for incorporation into the annual reports.

8 Laboratory Procedures and Reporting of Results

The laboratory will select the appropriate sampling containers for the chemical, physical, and/or biological constituents to be analyzed (Table 8) and will meet its internal quality control requirements for duplicate and spike analyses.

8.1 Record Keeping

The laboratory will keep appropriate records to indicate the following for each sample:

- Date, location, and time of sampling.
- Name(s) of individuals who performed the water sampling.
- Date and time samples were received by the laboratory.
- Temperature of the ice chest interior upon receipt by the laboratory.
- Date(s) analyses were made.
- Analytical testing methods used and detection limits.
- Analytical results.

8.2 Quality Assurance

The laboratory will adhere to a quality assurance program that follows accepted USEPA protocols. It must maintain state certification for drinking water analyses and perform routine analyses including known, commercially available standards. These QA/QC procedures are to be described in the laboratory's Quality Assurance and Quality Control Manual. The laboratory shall submit to the Owner a report that describes the quality assurance results, spike recovery, any problems discovered or identified for the analytical period covered at the laboratory, and any subcontract laboratories used.

All analysts must be certified or approved to perform the required analyses or have the necessary training. A copy of the certification and training records shall be available upon request.

8.3 Analytical Methods

The laboratory (including any subcontractor laboratory it may use) must use accepted laboratory analytical methods as specified in Table 8 where appropriate. USEPA limits on holding times must also be observed.

The laboratory (and any subcontractor laboratory it may use) must be certified by the State of California for the analytical methods used. Written test procedures, including quality control practices, shall be followed for each analytical method used to measure the parameters listed in Table 8.

Detection limits must be equal to or less than the detection limits for reporting purposes or State Action Levels for drinking water set forth by the California Department of Health Services. Table 8 lists the detection limits for each monitoring parameter.

8.4 Laboratory Reporting of Results

The laboratory will use a standard reporting form for all water sources listing date(s) of analysis, name(s) of person who analyzed the samples, analytical method(s) used, name of parameter analyzed, detection limit, units of measurement, and results of the analysis. Any analytical result of less than detectable shall be reported as less than the method detection limit. All nitrate analyses shall be reported as nitrate (as nitrate).

Paper and electronic copies of laboratory results and written reports shall be submitted by the laboratory to the Owner within 30 calendar days of receipt of the samples. Unusual spikes, questionable results, or detection of chemicals not on the list of required constituents will be promptly reported to the Owner. The laboratory will maintain records that show the calibration of equipment used in the various analyses for at least three years from the date the analytical reports were submitted to the designated sampling personnel.

9 Subsidence

The subsidence monitoring network consists of seven benchmarks around the City that will be surveyed annually.

9.1 Preparation for Field Work

A licensed California land surveyor of the City's choice shall be used to re-survey each of the seven benchmarks annually between March and April.

9.2 Data Review

The data will be graphed for review on an annual basis with the time along the x-axis and displacement along the y-axis. The plots, along with a discussion of the data, will be included in the annual groundwater monitoring report.

10 Recommendations

The subbasin contains two aquifers that are composed of multiple thin sand and gravel beds. An unconfined to semi-confined aquifer is present above the Corcoran clay. The aquifer is present in the recent alluvium and the upper portions of the Tulare Formation. The confined aquifer is present below the Corcoran clay to depth of about 900 feet bgs. The unconfined and confined aquifers merge where the Corcoran clay is absent, near the southwestern portion of the subbasin adjacent to the foothills and just west of the San Joaquin River.

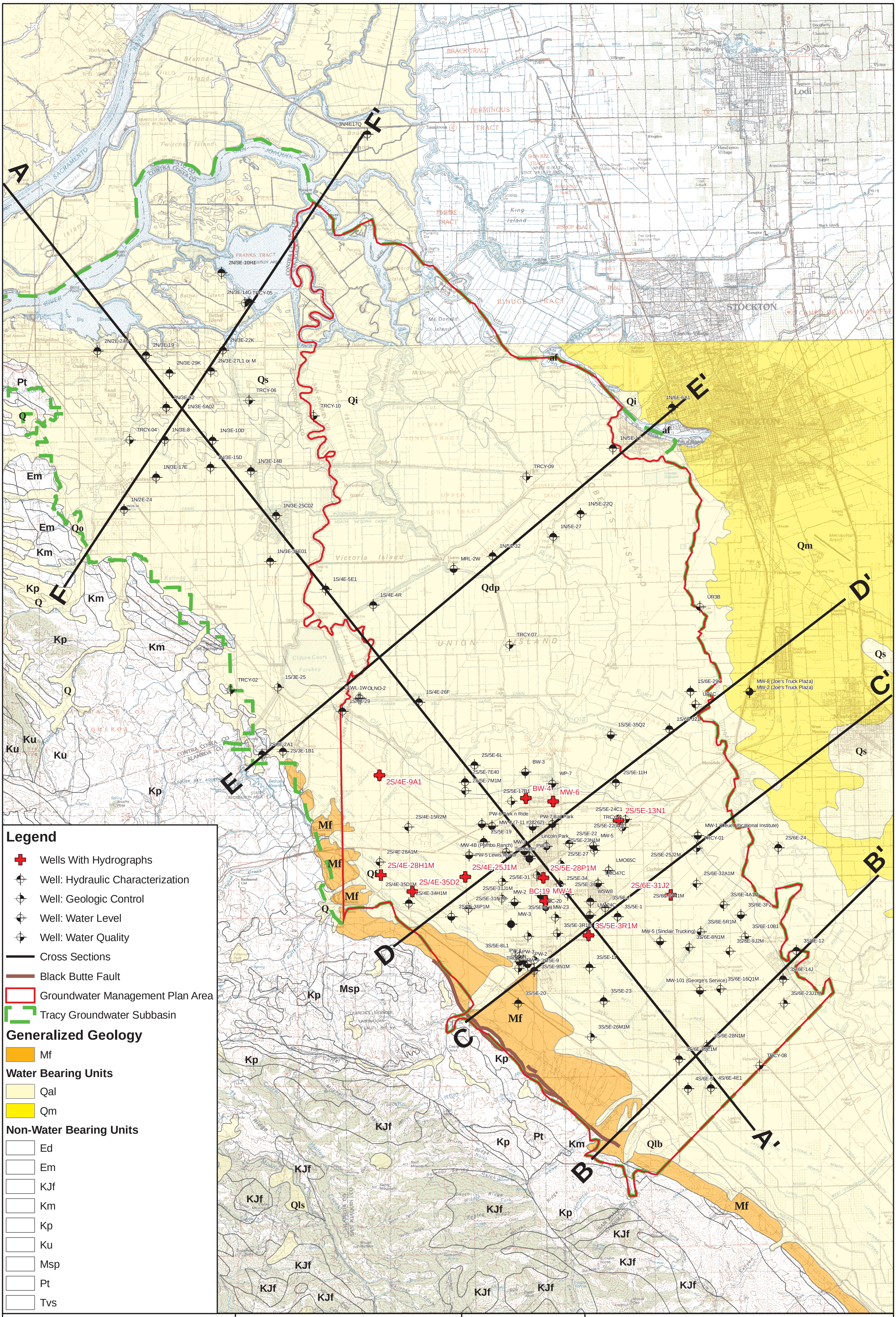
The geologic materials, water quality, and groundwater contours show groundwater recharge to the unconfined aquifers occurs from precipitation, deep percolation of imported irrigation water, and recharge from creeks from the Coastal Ranges. Pumping in the unconfined aquifers could induce groundwater recharge from the Sacramento and San Joaquin Rivers. Groundwater recharge to the confined aquifer occurs in the foothills adjacent to the Coast Ranges through the fanglomerate, from the west side of the San Joaquin River, and in some areas through wells that are screened in both the unconfined and confined aquifers.

Based on the conceptual understanding of the geology and aquifers, we recommend that the following actions be undertaken to secure a more complete understanding of the hydrogeology:

- Obtain well construction details for both groundwater level and production wells.
- Establish an extensometer in one of the City's monitoring wells to more fully assess subsidence.
- Construct dedicated monitoring wells to monitor groundwater levels in the confined aquifers.
- Replace environmental monitoring wells constructed into the unconfined aquifer with dedicated monitoring wells.
- Request that DWR reactivate some of its historic monitoring wells and incorporate these into the monitoring network.
- Request DWR to monitor, on a quarterly basis, selected wells that are currently being used for levee stability evaluations.

Because significant data will be generated, a database should be developed to archive the measurements for interpretation for each annual report and to develop trends in ground levels and quality.

Figures



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Tracy Regional
Groundwater Management Plan

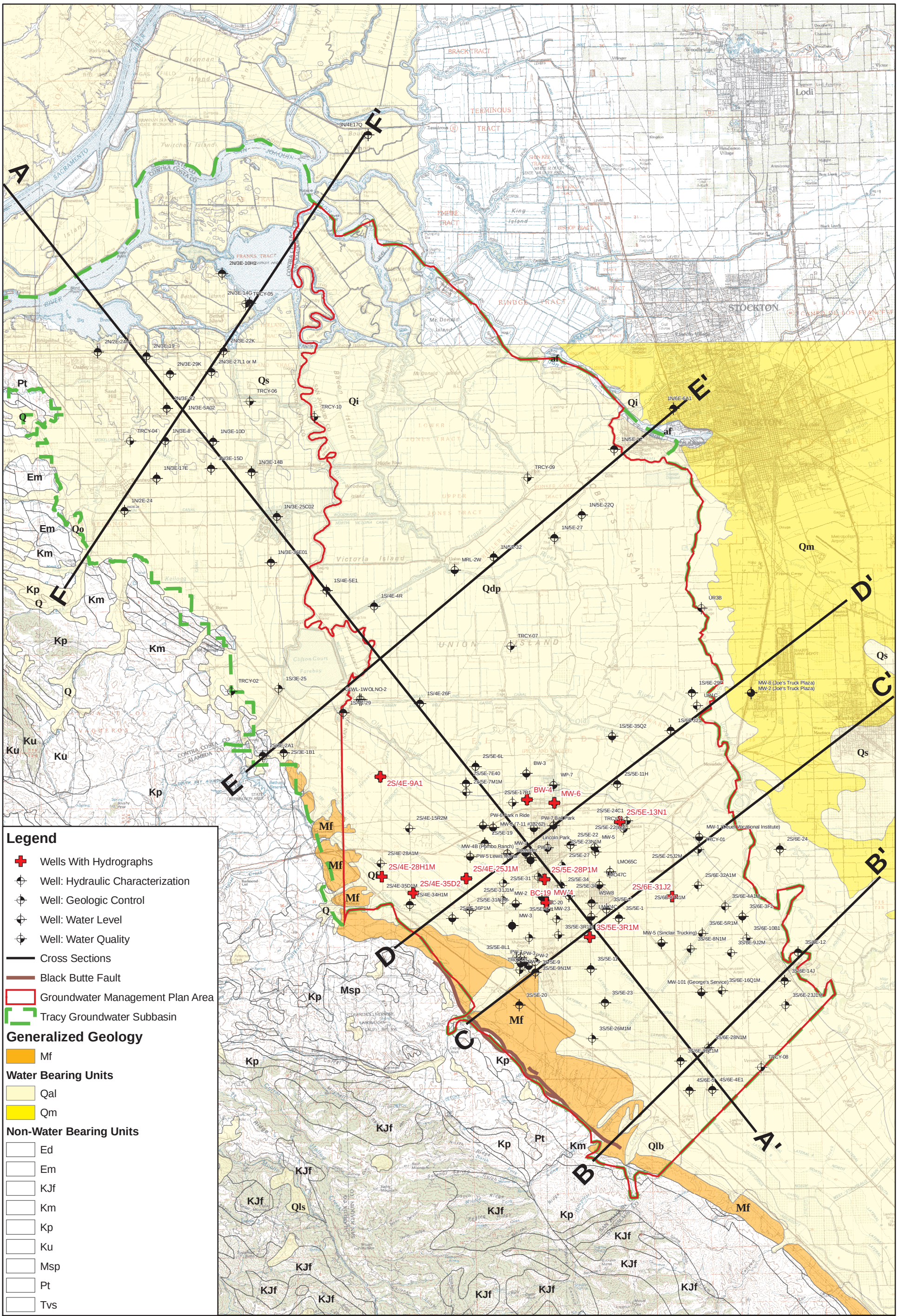
San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

WELL LOCATIONS AND
GENERALIZED GEOLOGY IN
TRACY GROUNDWATER SUBBASIN

JANUARY 2007

FIGURE 1


Legend
Wells With Hydrographs
Well: Hydraulic Characterization
Well: Geologic Control
Well: Water Level
Well: Water Quality
Cross Sections
Black Butte Fault
Groundwater Management Plan Area
Tracy Groundwater Subbasin
Generalized Geology
Mf
Water Bearing Units
Qal
Qm
Non-Water Bearing Units
Ed
Em
KJf
Km
Kp
Ku
Msp
Pt
Tvs
A
A'
B
B'
C
C'
D
D'
E
E'
F
F'
Lodi
STOCKTON
Qm
Qdp
Qi
Qs
Qlb
Qls
Mf
Q
Pt
Km
Kp
KJf
Msp
Ku
Em
2S/4E-9A1
BW-4
MW-6
2S/5E-13N1
2S/4E-28H1M
2S/4E-25J1M
2S/5E-28P1M
2S/4E-35D2
2S/6E-31J2
3S/5E-3R1M
BC-19
MW-4
2S/4E-15R2M
2S/5E-17B1
2S/5E-24C1
2S/5E-22(ISD)
2S/5E-19
2S/5E-23N1M
2S/5E-27
2S/5E-25J2M
2S/4E-28A1M
2S/4E-35D1M
2S/4E-34H1M
2S/5E-31
2S/5E-31J1M
2S/5E-31N1M
2S/5E-36P1M
2S/5E-34
2S/6E-32A1M
3S/6E-4A1M
3S/6E-3F2
3S/6E-5R1M
3S/6E-10B1
3S/6E-8N1M
3S/6E-9J2M
3S/6E-12
3S/6E-14J
3S/6E-23J1M
3S/6E-16Q1M
3S/5E-8L1
3S/5E-11
3S/5E-9
3S/5E-9N1M
3S/5E-20
3S/5E-23
3S/5E-26M1M
3S/6E-28N1M
3S/6E-33E1M
4S/6E-4E1
MW-5 (Sinclair Trucking)
MW-101 (George's Service)
MW-8 (Joe's Truck Plaza)
MW-2 (Joe's Truck Plaza)
MW-1 (Beuel Vocational Institute)
TRCY-01
TRCY-08
2N/3E-10H1
2N/3E-14G
TRCY-05
2N/2E-24H
2N/3E-19
2N/3E-22K
2N/3E-29K
2N/3E-27L1 or M
2N/3E-32
1N/3E-5A02
TRCY-04
1N/3E-8
1N/3E-10D
1N/3E-15D
1N/3E-17E
1N/3E-14B
TRCY-06
TRCY-10
TRCY-09
1N/2E-24
1N/3E-25C02
1N/3E-35E01
1N/5E-22Q
1N/5E-27
1N/5E-32
1N/6E-6A1
1N/5E-15
MRL-2W
1S/4E-5E1
1S/4E-4R
1S/3E-25
TRCY-02
GWL-1WOLNO-2
1S/4E-29
1S/4E-26F
TRCY-07
1S/6E-29F
1S/6E-32J
1S/5E-35Q2
2S/5E-2A1
2S/3E-1B1
2S/5E-6L
2S/5E-7E40
2S/5E-7M1M
2S/5E-11H
BW-3
WP-7
PW-6 Park n Ride
PW-7 Ball Park
Lincoln Park
MW-4B (Pombo Ranch)
PW-5 Lewis Market
LMO65C
LMO47C
WSW8
LMO24C
MW-2
MW-3
MW-23
PW-3
PW-2
Tracy Regional
Groundwater Management Plan
San Joaquin County, California
GEI Consultants
Bookman-Edmonston Division
WELL LOCATIONS AND
GENERALIZED GEOLOGY IN
TRACY GROUNDWATER SUBBASIN
JANUARY 2007
FIGURE 2
Miles
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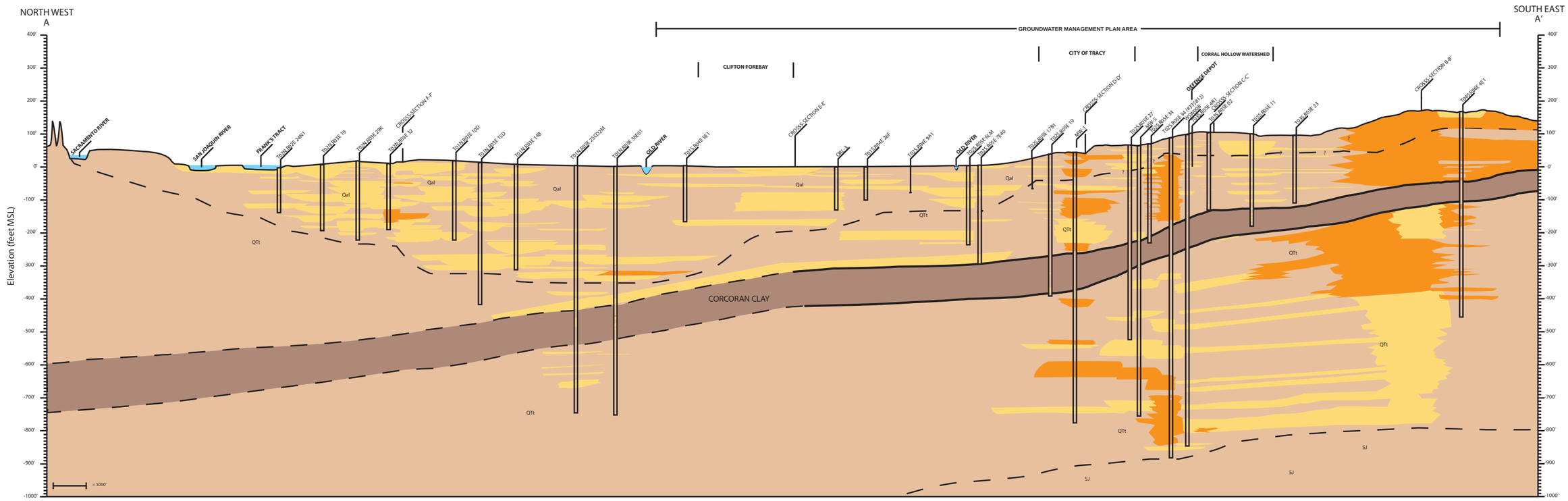


LEGEND

Qal: Alluvium
QTt: Tulare Fm
Mf: Fanglomerate
Kp: Panoche Fm
SJ: San Joaquin Clays

GRAVELS
SANDS
SILT/CLAY
CORCORAN CLAY

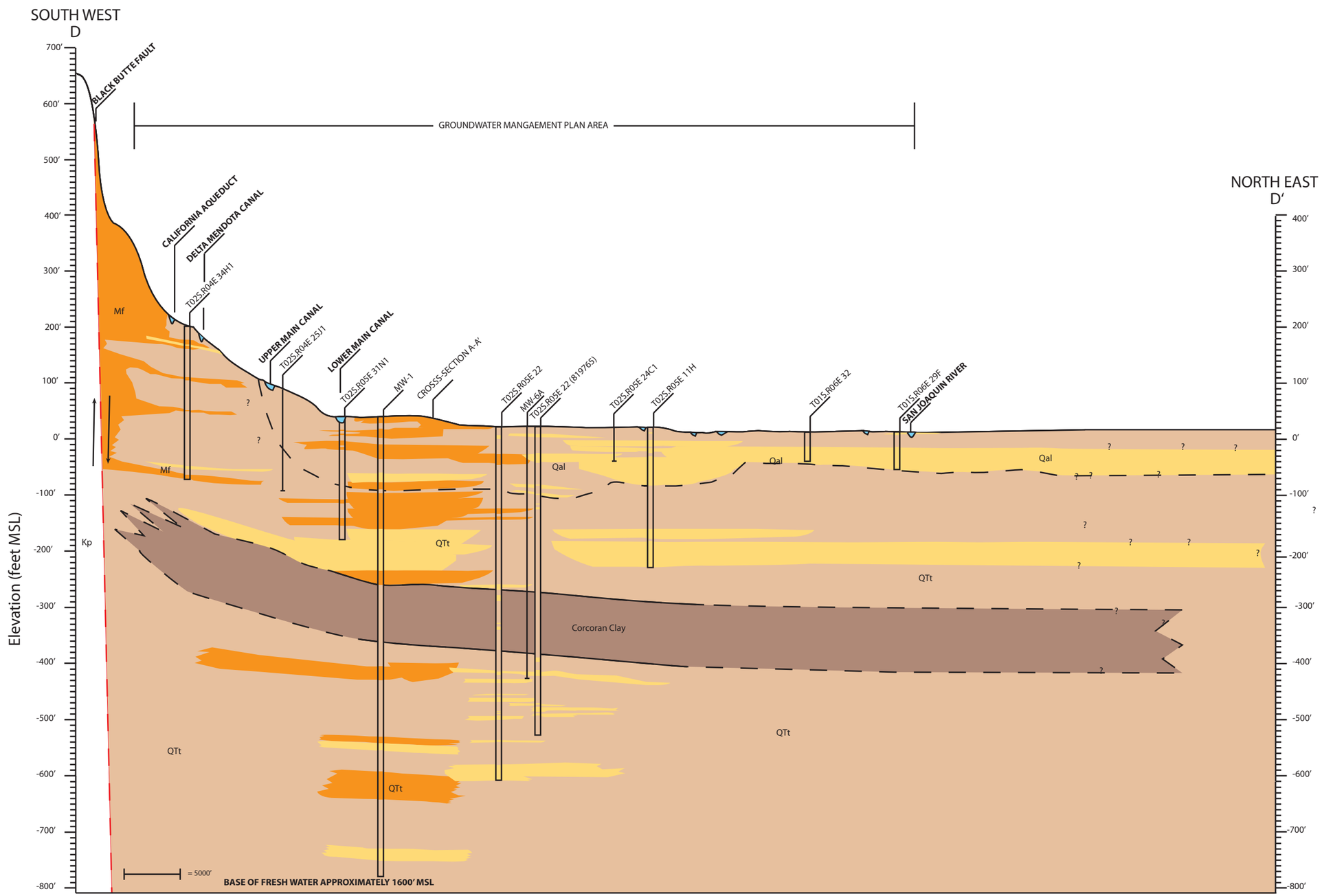
Fault, arrows showing direction of movement

Geologic contact. Dashed where inferred, question mark where unkown

= Wells used for geology, hydrogeology interpretation and water quality and levels where available.

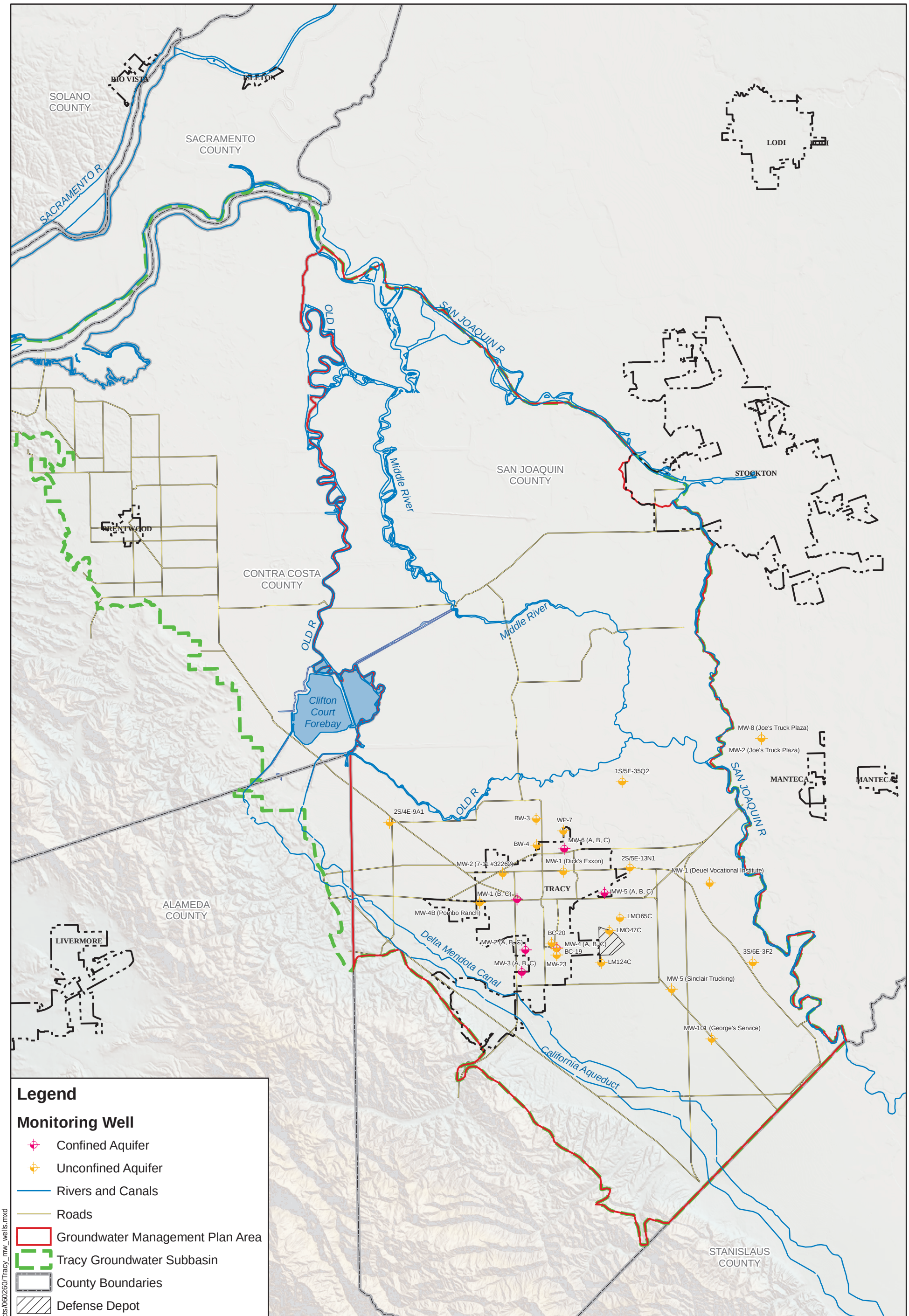
= Wells used for water quality and water level data.

Groundwater Monitoring Program	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION A-A'
City Of Tracy		JANUARY 2007 FIGURE 3



* SEE LEGEND (FIGURE 2)

Groundwater Monitoring Program	GEI Consultants Bookman-Edmonston Division	GEOLOGIC CROSS-SECTION D-D'
City Of Tracy		JANUARY 2007 FIGURE 4



Tracy Regional
Groundwater Management Plan

San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

Groundwater Lever and Water Quality
Monitoring Well Network
in Tracy Groundwater Subbasin

JANUARY 2007

FIGURE 5

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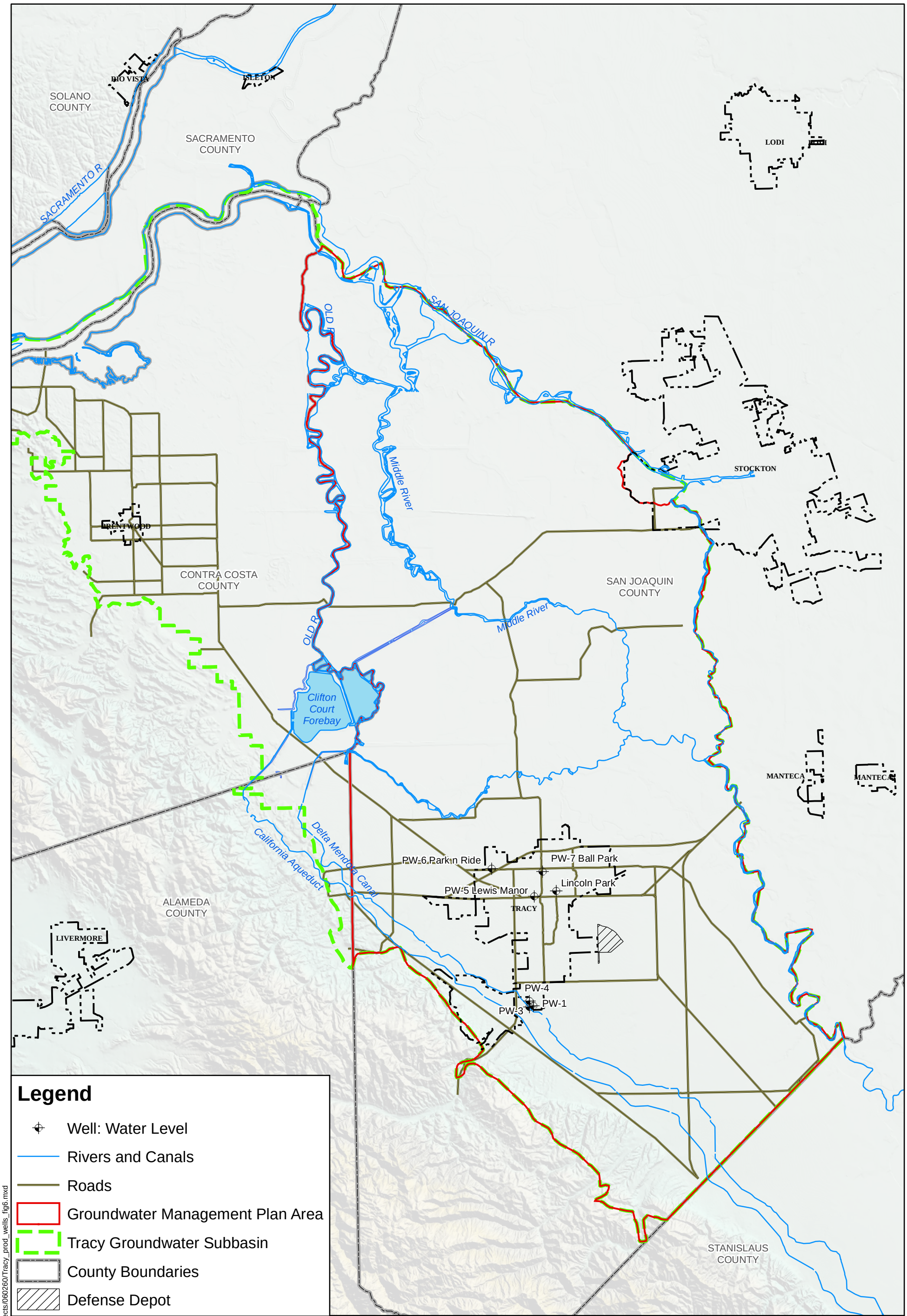

Tracy Regional Groundwater Management Plan

San Joaquin County, California

GEI Consultants
Bookman-Edmonston Division

Groundwater Pumping Monitoring Network in Tracy Groundwater Subbasin

JANUARY 2007

FIGURE 6

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Tables

TABLE 1
UNCONFINED AQUFIER MONITORING WELLS CONSTRUCTION DETAILS

Well ID	Owner	Reference Point Elevation (Feet MSL)	Total Depth (Feet bgs)	Screen Interval (Feet bgs)
LMO65C	**Tracy Army Depot**	64*	166.0	144-160
LM124C	**Tracy Army Depot**	112*	150.0	147-157
LMO47C	**Tracy Army Depot**	78*	144.0	123-134
02S4E09A001M	**San Joaquin County**	47	110	80-100
02S05E13N001M	**San Joaquin County**	24	172	115-135
				44-168
01S05E35Q002M	**San Joaquin County**	8	305	225-245
03S06E03F002M	**San Joaquin County**	29	138	118-135
MW1 **	**Dick's Exxon**	28.37	19.68	NA
MW-2 **	**7-11 #32262**	25.32	17	7-17
MW-4B **	**Pombo Ranch**	53.55	20.40	NA
MW-1 **	**Deuel Vocational Institute**	14.32	NA	NA
MW-101 **	**George's Service**	85.84	37.58	NA
MW-5 **	**Sinclair Trucking**	75.88	20.01	85
MW-2 **	**Joe's Truck Plaza**	13.68	20	NA
MW-8 **	**Joe's Truck Plaza**	14.55	40	23-38
WELL BW-3	**Spreckles Sugar**	4.59	90.30	NA
WELL BW-4	**Spreckles Sugar**	10.12	102.10	NA
WELL WP-7	**Spreckles Sugar**	16.64	99.73	NA
Well BC-19	**Georgia-Pacific**	98.78	NA	NA
Well BC-20	**Georgia-Pacific**	89.53	NA	NA
Well MW-23	**Georgia-Pacific**	102.24	NA	NA

NA= Not Available
*Approximated values
** Geotracker wells.
Geotracker Website: http://geotracker.swrcb.ca.gov/search/casesearch.htm
Insert site case number at Geotracker website for current site information.

Well ID	Site	Case Number
MW1 **	Dick's Exxon	390629
MW-2 **	7-11 #32262	391147
MW-4B **	Pombo Ranch	391027
MW-1 **	Deuel Vocational Institute	390037
MW-101 **	George's Service	390375
MW-5 **	Sinclair Trucking	390133
MW-2 **	Joe's Truck Plaza	231585
MW-8 **	Joe's Truck Plaza	231585

TABLE 2
CONFINED AQUIFER MONITORING WELLS CONSTRUCTION DETAILS

Well ID	Owner	Reference Point Elevation (Feet MSL)	Annular Seal (Feet)	Filter Pack Interval (Feet)	Screen Interval (Feet)
MW-1B	**City of Tracy**	50.09	0-590	590-670	618-658
MW-1C	**City of Tracy**	51.20	0-720	720-800	748-788
MW-2A	**City of Tracy**	92.59	0-400	400-480	426-466
MW-2B	**City of Tracy**	92.53	0-614	614-690	634-674
MW-2C	**City of Tracy**	92.53	0-760	760-820	770-810
MW-3A	**City of Tracy**	137.86	0-370	370-415	382-402
MW-3B	**City of Tracy**	138.08	0-530	530-595	540-580
MW-3C	**City of Tracy**	138.22	0-726	726-820	770-810
MW-4A	**City of Tracy**	104.08	0-440	440-505	450-490
MW-4B	**City of Tracy**	102.75	0-660	660-715	680-700
MW-4C	**City of Tracy**	103.11	0-760	760-820	770-810
MW-5A	**City of Tracy**	48.39	0-390	390-460	406-446
MW-5B	**City of Tracy**	47.82	0-560	560-640	576-616
MW-5C	**City of Tracy**	48.06	0-750	750-820	770-810
MW-6A	**City of Tracy**	26.52	0-400	410-450	400-465
MW-6B	**City of Tracy**	26.65	0-560	560-645	590-630
MW-6C	**City of Tracy**	26.79	0-730	755-810	755-795
Lincoln	**City of Tracy**	44.58	0-250	250-980	490-980
Production Well No. 1	**City of Tracy**	202.25	0-300	300-980	450-550
					580-980
Production Well No. 2	**City of Tracy**	202.67	0-250	250-850	420-850
Production Well No. 3	**City of Tracy**	215.6	0-250	250-890	420-890
Production Well No. 4	**City of Tracy**	202.08	0-250	250-940	380-940
Production Well No. 5	**City of Tracy**	49	0-305	305-990	410-480
(Lewis Manor)			0-500		601-630
			690-700		650-670
			580-870		805-830
					900-930
					965-990
Production Well No. 6	**City of Tracy**	27	0-500	500-690	550-598
(Park and Ride)			690-700	700-850	610-636
			580-870	870-1216	656-678
					738-754
					774-796
					966-982
					1014-1122
					1176-1196
Production Well No. 7	**City of Tracy**	22	0-490	490-750	550-598
(Ball Park)			750-770	770-914	570-732
					850-874
Production Well No. 8	**City of Tracy**	Unkown	0-340	340-850	370-460
(ASR)					510-640
					680-820

TABLE 3
GROUNDWATER PUMPING WELLS CONSTRUCTION DETAILS

Well ID	Well Name	Owner	Reference Point Elevation (Feet MSL)	Annular Seal (Feet bgs)	Filter Pack Interval (Feet bgs)	Screen Interval (Feet bgs)
Lincoln		**City of Tracy**	44.58	0-250	250-980	490-980
Tidewater		**City of Tracy**	56.5	0-200	200-1159	340-400
						404-488
						510-637
						680-863
						886-912
						934-978
						1031-1159
Production Well No. 1		**City of Tracy**	202.25	0-300	300-980	450-550
						580-980
Production Well No. 2		**City of Tracy**	202.67	0-250	250-850	420-850
Production Well No. 3		**City of Tracy**	215.6	0-250	250-890	420-890
Production Well No. 4		**City of Tracy**	202.08	0-250	250-940	380-940
Production Well No. 5		**City of Tracy**	49	0-305	305-990	410-480
(Lewis Manor)				0-500		601-630
				690-700		650-670
				580-870		805-830
						900-930
						965-990
Production Well No. 6		**City of Tracy**	27	0-500	500-690	550-598
(Park and Ride)				690-700	700-850	610-636
				580-870	870-1216	656-678
						738-754
						774-796
						966-982
						1014-1122
						1176-1196

TABLE 3 CONTINUED
GROUNDWATER PUMPING WELLS CONSTRUCTION DETAILS

Well ID	Well Name	Owner	Reference Point Elevation (Feet MSL)	Annular Seal (Feet bgs)	Filter Pack Interval (Feet bgs)	Screen Interval (Feet bgs)
Production Well No. 7		**City of Tracy**	22	0-490	490-750	550-598
(Ball Park)				750-770	770-914	570-732
						850-874
Production Well No. 8		**City of Tracy**	Unkown	0-340	340-850	370-460
(ASR)						510-640
						680-820
2S5E36E	**Tusquellas**	**Alvarez Farms**				
3S5E14DZ	**Steinhausen**	**Steinhausen**				
3S5E14Q	**Sasaki**	**K. Sasaki**				
3S5E24J	**Bird Road**	**C&A Navarra**				
3S6E8R	**Maciel**	**Yamasaki Farms**				
3S6E9E	**Paulson Ranch**	**Thoming & Williams**				
3S6E16E	**Miaciel Silos**	**Yamasaki Farms**				
3S6E20N	**D. Petz**	**Dame & Michael Petz**				
3S6E28G	**Thoming**	**Ed Thoming and Sons**				
2S6E31J02	**BC1**	**DWR**				
3S5E03P01	**BC2**	**Public**				
3S5E03R03	**BC3**	**Public**				
3S5E09C01	**BC4**	**Public**				
3S5E10D01	**BC6**	**Public**				
3S5E11D01	**BC7**	**Public**				
3S6E050R1	**BC8**	**DWR**				
3S6E18B01	**BC10**	**DWR**				
3S6E18N01	**BC11**	**Public**				
3S6E34J01	**BC14**	**Public**				
3S6E34J02	**BC15**	**Public**				
WSW 7	**WSW 7**	**Army Depo**	110.74			
WSW 8	**WSW 8**	**Army Depo**	99.95			
WSW 9	**WSW 9**	**Army Depo**	94.73			
Well #1	**Well #1**	**Los Ranchos**				
Well #1	**Well #1**	**Corral Hollow Water Sys.**				
Well #2	**Well #2**	**Corral Hollow Water Sys.**				
Well #2	**Well #2**	**Fairoaks Water Sys.**				
Well #3	**Well #3**	**Fairoaks Water Sys.**				
Well #4	**Well #4**	**Fairoaks Water Sys.**				

Table 4
Benchmark Elevations

Station Name	Easting (feet)	Northing (feet)	2003 Elevation (feet)*	2004 Elevation (feet)	2005 Elevation (feet)	2006 Elevation (feet)	2007 Elevation (feet)	2008 Elevation (feet)
101	**6289677.616**	**2072154.574**	212.038	212.0439	212.044			
102	**6302094.558**	**2094264.828**	46.031	46.03002	46.030			
103	**6298578.149**	**2100988.252**	25.193	25.17299	25.173			
104	**6281516.747**	**2102500.785**	15.022	15.00396	15.004			
105	**6291675.753**	**2097926.827**	29.804	29.81417	29.814			
106	**6285146.737**	**2092920.212**	45.641	45.6246	45.625			
107	**6291933.571**	**2082479.966**	111.533	111.5471	111.547			

* Base elevations determined by land & global positioning survey conducted by Stoddard & Associates, 2003; The results are the product of the 2005/2004 GPS ellopsoid height differences applied to the 2003 land leveld height values. The results are at the design accuracy of the survey (2cm). All stations indicate lower elevations at similar values. These results appear to indicate a fairly uniform trend of subsidence.

Table 5
Groundwater Monitoring Frequency

Well ID	Owner	Frequency		
		Groundwater Pumping	GW Level and Conductivity	Water Quality
LMO65C	**Tracy Army Depot**	Monthly	--	--
LM124C	**Tracy Army Depot**	Monthly	--	--
LMO47C	**Tracy Army Depot**	Monthly	--	--
WSW 7	**Tracy Army Depot**	Monthly	--	--
WSW 8	**Tracy Army Depot**	Monthly	--	--
WSW 9	**Tracy Army Depot**	Monthly	--	--
02S4E09A001M	**San Joaquin County**	Monthly	--	--
02S05E13N001M	**San Joaquin County**	Monthly	--	--
01S05E35Q002M	**San Joaquin County**	Monthly	--	--
03S06E03F002M	**San Joaquin County**	Monthly	--	--
MW1	**Dick's Exxon**	--	Quarterly*	Annually**
MW-2	**7-11 #32262**	--	Quarterly*	Annually**
MW-4B	**Pombo Ranch**	--	Quarterly*	Annually**
MW-1	**Deuel Vocational Institute**	--	Quarterly*	Annually**
MW-101	**George's Service**	--	Quarterly*	Annually**
MW-5	**Sinclair Trucking**	--	Quarterly*	Annually**
MW-2	**Joe's Truck Plaza**	--	Quarterly*	Annually**
MW-8	**Joe's Truck Plaza**	--	Quarterly*	Annually**
WELL BW-3	**Spreckles Sugar**	--	Quarterly*	Quarterly*
WELL BW-4	**Spreckles Sugar**	--	Quarterly*	Quarterly*
WELL WP-7	**Spreckles Sugar**	--	Quarterly*	Quarterly*
Well BC-19	**Georgia-Pacific**	--	Quarterly*	Annually**
Well BC-20	**Georgia-Pacific**	--	Quarterly*	Annually**
Well MW-23	**Georgia-Pacific**	--	Quarterly*	Annually**
MW-1B	**City of Tracy**	--	Quarterly*	Quarterly*
MW-1C	**City of Tracy**	--	Quarterly*	Quarterly*
MW-2A	**City of Tracy**	--	Quarterly*	Quarterly*
MW-2B	**City of Tracy**	--	Quarterly*	Quarterly*
MW-2C	**City of Tracy**	--	Quarterly*	Quarterly*
MW-3A	**City of Tracy**	--	Quarterly*	Quarterly*
MW-3B	**City of Tracy**	--	Quarterly*	Quarterly*
MW-3C	**City of Tracy**	--	Quarterly*	Quarterly*
MW-4A	**City of Tracy**	--	Quarterly*	Quarterly*
MW-4B	**City of Tracy**	--	Quarterly*	Quarterly*
MW-4C	**City of Tracy**	--	Quarterly*	Quarterly*
MW-5A	**City of Tracy**	--	Quarterly*	Quarterly*
MW-5B	**City of Tracy**	--	Quarterly*	Quarterly*
MW-5C	**City of Tracy**	--	Quarterly*	Quarterly*
MW-6A	**City of Tracy**	--	Quarterly*	Quarterly*
MW-6B	**City of Tracy**	--	Quarterly*	Quarterly*
MW-6C	**City of Tracy**	--	Quarterly*	Quarterly*
Lincoln	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 1	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 2	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 3	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 4	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 5	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 6	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 7	**City of Tracy**	Monthly	Quarterly*	Quarterly*
Production Well No. 8	**City of Tracy**	Monthly	Quarterly*	Quarterly*

Notes:

* Quarterly monitoring performed in March, July, August, October

-- Indicates Not Monitored

**Annual water quality samples shall be collected in July of each year

TABLE 6
GROUNDWATER PUMPING MONITORING FORM

OBSERVER:_____

DATE:_____

Well ID	Time	Totalizer		Units	Comments
		Start	Finish		

TABLE 7
Groundwater Sampling and Purge Volume Form

1. WELL SITE ID NO.: _____
2. DATE: _____
3. TIME: _____
4. WELL DIAMETER: _____ inches (in)
5. WELL DEPTH: _____ feet (ft)
6. DEPTH TO WATER: _____ (ft)
7. COLUMN OF WATER (line 7 - line 6):_____ (ft)
8 TOTALIZER READING (IF AVAILABLE):_____
9 LOW FLOW PURGE: YES_____ NO_____

FIELD TECH(S): _____

WELL IS: IDLE_____ PUMPING_____

WEATHER CONDITIONS: _____ (eg. hot, cold, clear, etc)

REFERENCE POINT (R.P) _____ (ft)

DESCRIPTION:_____ (eg. top of casing)

EC METER (TYPE AND MODEL NO.)_____

CALIBRATED (yes/no)_____DATE:_____

FIELD CALIBRATED (yes/no)_____DATE:_____

EC MEASUREMENT FROM WELL _____

WATER QUALITY SAMPLE COLLECTED: YES_____ NO_____

WELL VOLUME CALCULATION

10. ONE WELL VOLUME (**V**) = Enter Line 5 (in) = _____ / 24=(_____)^2= _____x 3.1416=_____ x line 8=_____ft^3
11. ONE WELL VOLUME (**V** in gallons) = $V_{(line\ 9)}$ x 7.48 = _____ gal
12. THREE WELL VOLUMES (in gallons) = $V_{(line\ 10)}$ x 3 = _____ gal

WELL PURGE TIME CALCULATION

13. WELL DISCHARGE RATE (**Q**) (with 5-gallon bucket) = 5 gal / ____ seconds x 60 sec/min = _____ gallons per minute (gpm) or _____ gpm from meter
14. WELL PURGE TIME (ONE WELL VOLUME) = $\mathbf{V}_{(line\ 10)}$ / $\mathbf{Q}_{(line\ 13)}$ = _____ min
15. WELL PURGE TIME (THREE WELL VOLUMES) = $\mathbf{V}_{(line\ 11)}$ / $\mathbf{Q}_{(line\ 13)}$ = _____ min

ADDITIONAL FIELD NOTES

16. TIME PUMP TURNED "ON": _____
17. TIME PUMP TURNED "OFF": _____
18. ELAPSED PURGE TIME: _____ (min)

COMMENTS

* Electronic spreadsheet to automatically compute purge volume and time available upon request from B-E/GEI.

TABLE 8
Analytical Parameters, Test Methods, Holding Times,
Sample Containers, Preservation and Approximate Detection Limits

Parameter	ANALYTICAL TESTING METHOD	MAXIMUM HOLDING TIME	SAMPLE CONTAINER		PRESERVATION	MINIMUM REPORTING LIMIT
			BOTTLE TYPE	SIZE/SET		
Total Dissolved Solids	SM 2450-C	7 Days	Plastic	250 mL	Cool to 4 ^{o}C	1.0 mg/L
Chloride	EPA 300.0	28 Days	Plastic	125 mL	Cool to 4 ^{o}C	0.2 ug/L
Boron	EPA 200.7	6 months	Plastic	200 mL	Cool to 4 ^{o}C, HNO_3	0.1 mg/L
Sulfate	EPA 300.0, 375	28 Days	Plastic	250 mL	Cool to 4 ^{o}C	1.0 mg/L
Nitrate	EPA 300.0, 352.1	48 Hours	Plastic	250 mL	Cool to 4 ^{o}C	0.50 mg/L

TABLE 9

CLS - Labs CHAIN OF CUSTODY CLS ID No.; _____ LOG NO. WEB FORM

REPORT TO:

NAME AND ADDRESS

PROJECT MANAGER PHONE#

PROJECT NAME

SAMPLED BY

JOB DESCRIPTION

SITE LOCATION

CLIENT JOB NUMBER

DESTINATION LABORATORY

☐ CLS (916) 638-7301
3249 FITZGERALD RD.
RANCHO CORDOVA, CA.
95742

☐ OTHER

PRESERVATIVES

ANALYSIS REQUESTED

GEOTRACKER:
EDF REPORT ☐ YES ☐ NO
GLOBAL ID: _____

COMPOSITE:

FIELD CONDITIONS:

TURN AROUND TIME: 1 DAY | 2 DAY | 5 DAY | 10 DAY

SPECIAL INSTRUCTIONS OR ALT. ID:

DATE	TIME	SAMPLE IDENTIFICATION	MATRIX	CONTAINER NO.	CONTAINER TYPE

INVOICE TO:

P.O. #

QUOTE #

SUSPECTED CONSTITUENTS

PRESERVATIVES: (1) HCL (2) HNO_3 (3) = COLD (4) = NaOH (5) = H_2SO_4 (6) = $Na_2S_2O_3$ (7) =

RELINQUISHED BY (SIGN)	PRINT NAME / COMPANY	DATE / TIME	RECEIVED BY (SIGN)	PRINT NAME / COMPANY

REC'D AT LAB BY: DATE / TIME: CONDITIONS / COMMENTS:

SHIPPED BY: ☐ FED X ☐ UPS ☐ OTHER _____ AIR BILL #

Appendix F

F. Stakeholder Involvement Documentation

Invited Stakeholders for Tracy Regional Groundwater Management Plan

Mel Lytle
Eastern San Joaquin County IRWMP
1810 East Hazelton Avenue
Stockton, CA 95205

Ernie Pombo, Jr.
The West Side Irrigation District
P. O. Box 177
Tracy, CA 95378-0177

Jack Alvarez
The West Side Irrigation District
P. O. Box 177
Tracy, CA 95378-0177

Rick Gillmore
Byron-Bethany Irrigation District
P. O. Box 160
Byron, CA 94514

David Weisenberger
Banta-Carbona Irrigation District
3514 W. Lehman Road
Tracy, CA 95304

Ron Roos
West Stanislaus Irrigation District
P. O. Box 37
Wesley, CA 95387

Bill Harrison
Del Puerto Water District
P. O. Box 1596
Patterson, CA 95363-1596

Naglee Birk Irrigation District
P. O. Box 1129
Tracy, CA 95376

John Herrick
South Delta Water Agency
4255 Pacific Avenue
Stockton, CA 95207

Dante Nomellini
Central Delta Water Agency
P. O. Box 1461
Stockton, CA 95201

Mike Robinson
Farm Bureau
P. O. Box 8444
Stockton, CA 95208

Scott Hudson
County Ag Commissioner
1868 E. Hazelton Avenue
Stockton, CA 95202

Ben Hall
Musco Family Olive Company
17950 Via Nicolo
Tracy, CA 95377

Donald Schnure
Tracy Biomass Plant
P. O. Box 1209
Tracy, CA 95378

Owens-Brockway Glass Container
14700 W. Schulte Road
Tracy, CA 95377

Marshall Cloud
Defense Logistics Agency
Defense Distribution Region West
P. O. Box 960001
Stockton, Ca 95296-0710

Stephanie Beck
Granite Construction
P. O. Box 151
Stockton, CA 95201

Paul Mercurio
Teichert Construction
3500 American River Drive
Sacramento, CA 95864-5805

Robert Aldenhuysen
RMC lonestar
Kerlinger Plan dba CEMEX-Kerlinger
30350 S. Tracy Boulevard
Tracy, CA 95376

Mark Nordberg
Department of Water Resources
901 “P” Street – 3rd Floor
Sacramento, CA 94236-0001

Mel Lytle
Eastern San Joaquin County FCWCD
1810 East Hazelton Avenue
Stockton, CA 95205

Frances Mizuno
San Luis and Delta Mendota Water Authority
15990 Kelso Road
Byron, Road 94514-9614

Joseph Spanos
Department of Health Services
31 E. Channel St., Room 270
Stockton, CA 95202

Claude Finn
Deuel Vocational Institution
P. O. Box 400
Tracy, CA 95378-0004

Regional Groundwater Management Plan for the

Tracy Groundwater Subbasin

Fall 2006

Project Update

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County have started preparing a regional groundwater management plan (GMP). The GMP will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area (shown at right).

The Project Team is currently characterizing the regional setting of the plan area. This includes identifying local water purveyors and summarizing land and water use conditions, available water supplies, and the hydrogeologic setting. The next step will include identifying local groundwater issues and developing Basin Management Objectives.

Parties interested in the GMP are encouraged to participate in the planning process by attending public meetings scheduled by the Groundwater Advisory Committee (GAC), and/or by requesting a draft of the plan when it becomes available and providing written comments to the City of Tracy. For meeting times and more information, please conctact Mr. Steve Bayley at the City of Tracy, below.

City of Tracy
Public Works Department
520 Tracy Blvd.
Tracy, CA, 95376

Phone: (209) 831- 4434
Email: steveb@ci.tracy.ca.us

Regional Groundwater Management Plan for the

Tracy Groundwater Subbasin

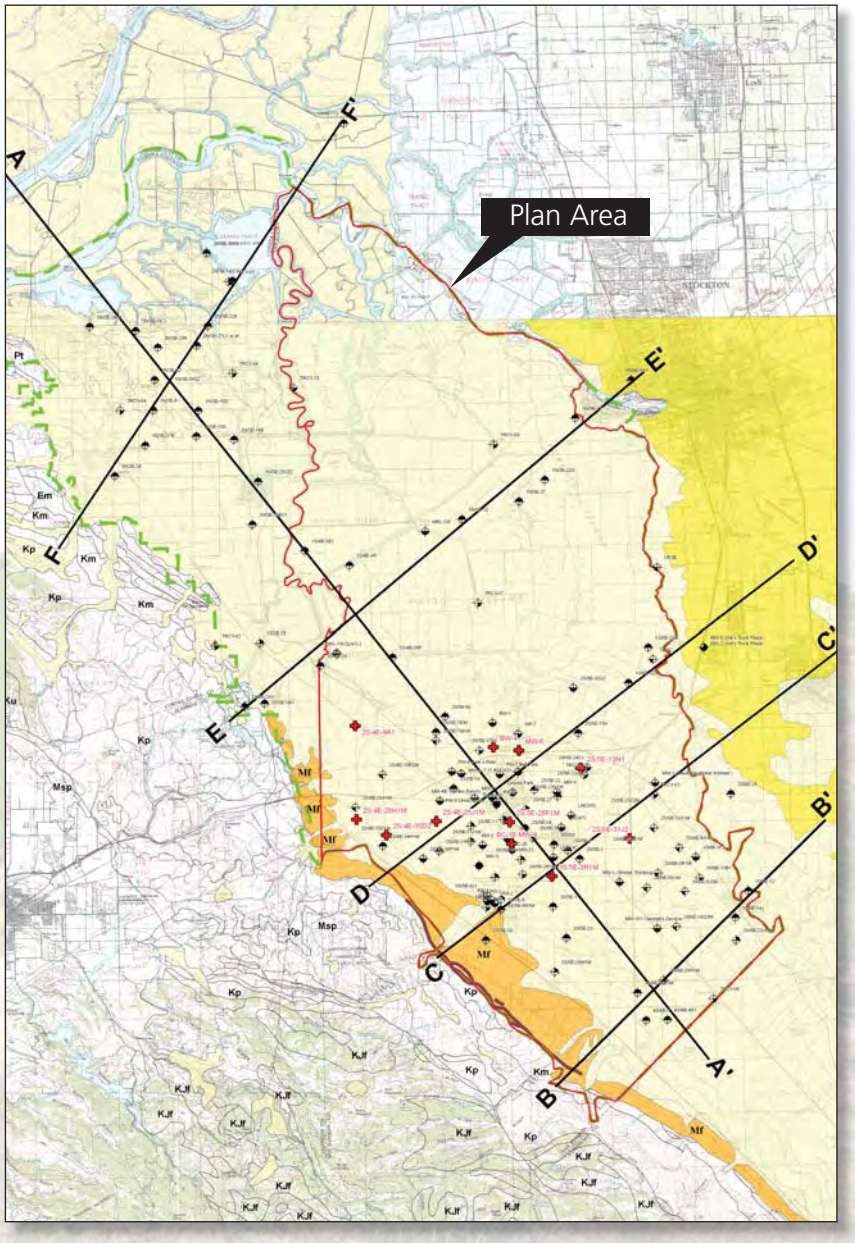
Winter 2006-2007

Project Update

The City of Tracy and other water entities located west of the San Joaquin River within San Joaquin County, are preparing a regional groundwater management plan (GMP). The GMP will address issues related to groundwater levels, groundwater quality, conjunctive management of groundwater and surface water, and measures to protect groundwater resources within the plan area (shown at right).

The Draft GMP is scheduled to be released for public review and comment on February 9, 2007 and will be distributed electronically via E-mail, or by compact disc. The GMP is scheduled for completion and adoption in March 2007.

Parties interested in the GMP are encouraged to participate in the planning process by attending public meetings scheduled by the Groundwater Advisory Committee (GAC), and/or by requesting a draft of the plan and providing written comments to the City of Tracy. For meeting times, or a copy of the Draft GMP, please contact Mr. Steve Bayley at the City of Tracy, below.



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