Chapter 4, part G. WATER TRANSFERS

PERTINENT CALFED GOALS AND OBJECTIVES

The goal of the Water Transfers Program is '*to provide a framework of actions, policies, and processes to facilitate, encourage and streamline a properly regulated and protective water market which will allow water to move between users, including environmental users, on a voluntary and compensated basis.*' (The CALFED Bay-Delta Program Water Transfer Program Appendix, Early Review Draft, October 1, 1998, 38 p)

A water transfer is the artificial conveyance of water diverted under a legal water right, a contract, or groundwater extraction, from one area to another, across a political or hydrologic boundary. Water transfers are considered a tool to take an identified supply of "extra" water, and convey that "extra" water to an area where there is presently a shortage of water for beneficial uses. This section addresses potential water transfers that involve the Central Valley aquifer system, including transfers that conjunctively involve surface and ground water.

The CALFED Program will not participate in water transfers as a water supplier or user but rather will act to facilitate transfers between willing parties when a proposed transfer meets the goals of the CALFED Program.

CALFED solution principles suggest water transfers should not:

- raise or lower groundwater to unacceptable levels,
- induce land subsidence to unacceptable levels,
- alter the quality of surface or ground water to unacceptable levels,
- precipitate unacceptable direct or indirect burdens on the socioeconomics of transfer areas
- increase or decrease groundwater discharge to the land surface, streams, and wetlands to unacceptable levels
- provide water for transfer that results in an unacceptable reduction in water for other beneficial users.

MONITORING, ASSESSMENT, AND RESEARCH OBJECTIVES

Monitoring, assessment, and research programs should provide data and information to determine the effect of a water transfer on the quantity and quality of surface water and groundwater, land subsidence, the biological system, and the socioeconomic setting, and should pursue the following objectives:

1. Establish background or ambient conditions.
2. Identify and evaluate trends.
3. Elucidate existing or emerging problems.
4. Provide program management guidance.
5. Increase knowledge of natural and human factors affecting the groundwater resource.
6. Ensure compliance with statutory and regulatory mandates.
7. Evaluate program effectiveness.

The goal of the proposed monitoring program is to collect the data that will be necessary to assess the effects of a water transfer.

The goal of the data-assessment program is to define the techniques and procedures necessary to quantitatively evaluate the monitoring data so that 1) effects of the water transfer can be distinguished from other water-resource management activities and natural system variability, and 2) assurance is provided that the transfer is operating within established guidelines.

The goal of the focused research program is to improve our understanding of important hydrologic, chemical, and socioeconomic processes to assure that monitoring and assessment are adequate to determine the effects of a water transfer.

CONCEPTUAL MODEL

Central Valley Aquifer System

The Central Valley of California is a north-northwest-trending topographic basin filled with tens of thousands of feet of gravel, sand, silt, and clay derived from the adjacent mountains. Surface water drains from the valley through a single outlet, the Carquinez strait, after passing through the inland delta of the Sacramento and San Joaquin Rivers. The foothill boundary of the Central Valley represents the areal extent of the valley's basin-fill aquifer system. The Central Valley aquifer system has been divided into two subregions— Sacramento Valley and San Joaquin Valley. They are separated by the Sacramento-San Joaquin delta.

Precipitation is more abundant along the east side of the valley. This precipitation produces runoff that is used for agricultural, groundwater recharge, and urban purposes. For this reason, every major east-side river has a dam and a reservoir. West-side streamflow is intermittent and flashy, but some watersheds do have dams. Flows from both sides of the valley contribute recharge to the aquifer.

Sacramento Valley Aquifer

The Sacramento Valley Aquifer system has been conceptualized as a single heterogeneous aquifer where aquifer hydraulic properties vary with the proportion of fine-grained sediment. Ground water in the Sacramento Valley is generally of good quality. Ground water on the east side of the valley is low in dissolved solids and high in silica, reflecting the quality of recharge water from the mostly granitic rocks of the Sierra Nevada and metamorphic rocks in the foothills. Reducing conditions produce high concentrations of dissolved trace elements (iron, manganese, and arsenic) near the center of the valley. Ground water on the west side of the valley is lower in silica and higher in dissolved solids concentrations than ground water on the east side. Dissolved solids concentrations generally increase from north to south along the axis of the Sacramento Valley.

San Joaquin Valley Aquifer

The Corcoran Clay Member of the Tulare Formation underlies about 5,000 square miles of the San Joaquin Valley, separating the basin fill sediments into a lower confined aquifer and upper unconfined to semiconfined aquifer. Groundwater on the west side of the valley contains a higher concentration of dissolved solids than groundwater on the east side. Groundwater on the east side of the valley is characterized predominantly by dissolved calcium, calcium-sodium, or calcium-magnesium bicarbonate. West side groundwater contains mostly dissolved sodium, magnesium, and calcium cations and sulfate and chloride anions.

Land subsidence caused by hydrocompaction of debris flow deposits, and compaction caused by extraction of ground water and hydrocarbons has occurred over wide areas of the San Joaquin Valley. Land subsidence from groundwater extraction has also occurred in the southwestern Sacramento Valley.

Groundwater flow and Aquifer Hydraulic Properties

The direction and rate of movement of ground water and solutes in alluvial aquifer systems is controlled by aquifer geometry, hydraulic properties of the sediments, and differences in hydraulic head in the saturated zone. Similarly, the relation between flow in streams and adjacent aquifers is controlled by the interconnection of high permeability sediments between the streambed and the aquifer.

Current knowledge of ground water in California rarely allows accurate prediction of where or when stream flow depletions will occur as a result of groundwater extraction. Surface flow decreases caused by ground water pumping increases could take place in a few days, a few weeks, or many months.

Baseline hydrogeologic characterization data are needed to adequately assess the movement of water and solutes in response to a water transfer. In addition, the ability to define areas of potential land subsidence and aquifer compaction is dependent on an accurate assessment of the spatial distribution of clay layers throughout the aquifer. Although there have been several studies on the geologic structure of the Central Valley, there are many gaps in the understanding of the overall structure of the aquifer, and very few detailed characterization studies have been completed.

Water balance
The availability of water resources in a particular area might be considered by a simple water balance:

Inflow – Outflow = Change In Storage

Each term in the simple balance equation has many components that must be measured or estimated. Surface water resources are quantified and managed by measuring runoff, reservoir level, releases, and water use. These components of the surface-water balance provide a means of closely managing the resource. In contrast, three equivalent components are absent in the management of groundwater resources -- recharge to the aquifer, extraction (pumpage), and water use. Without these components of the groundwater balance, it is difficult, if not impossible, to manage groundwater resources to the same degree as surface water.

Implementing a water transfer will alter the water balance (both ground water and surface water) for the area transferring the water and for the area receiving the water. Because ground water and surface water are dynamically linked, determination of the water balance must integrate components of both ground water and surface water. Groundwater levels, stream stage and discharge, and water levels in wetlands or other surface water bodies are all affected by changes in the overall water balance for the basin.

Under natural conditions, the amount of recharge (inflow) is equal to the amount of discharge (outflow), and changes in storage are minimal. However, stresses on the groundwater system, such as pumping, changes in stream discharge, and variations in net infiltration due to irrigation, alter the natural balance and result in a change of storage. Storage changes are reflected by fluctuations of water levels in the aquifer. Conjunctive use and artificial storage and recovery projects require water quality/quantity information to assess impacts and evaluate the success of any program.

Water balance calculations will help to define whether water proposed for sale is new, real, or paper water (see Appendix *VII.C* for definitions).

Socioeconomic Factors
There may be unintended effects on those not a party to a water transfer, such as adverse effects on other legal water users, local economies, and environmental resources. Indicators that could identify potential third-party impacts should be monitored.

It is generally recognized that certain types of transfers can have adverse impacts on local economic conditions. Fallowing transfers, for example, may result in lower agricultural production in the source area and may impact local employment of farm workers and others. Groundwater transfers or transfers of surface water with groundwater replacement may result in lower groundwater levels, lower groundwater quality and higher pumping costs for other local groundwater users. In extreme cases, impacted groundwater users may lose the use of existing wells because of water quality degradation, and/or lower groundwater levels.

MONITORING PLAN ELEMENTS

To achieve monitoring and research objectives, two scales of monitoring are required -- regional and site specific. The data collected from regional and site-specific networks complement each other, and provide a comprehensive evaluation of the effects of a project. Regional data are adequate for detecting generalized trends or gross changes in flow patterns, water quality, or land-surface elevation.

Site-specific monitoring measures the effects of a particular project on local conditions, such as local pumping depressions, water quality, sensitive environmental habitats or local economies. Site-specific monitoring should be of sufficient detail to provide a means of distinguishing between the effects of the project and of other ongoing activities in a particular area. Design of site-specific monitoring networks at groundwater extraction sites will depend on details provided during site characterization studies.

In both types of monitoring networks, establishing baseline conditions is essential to assess the effects of the project. Assessment of the effects of water transfers, especially during the initial phases of a transfer, will of necessity rely heavily on the regional baseline data.

Without improvements to existing monitoring networks, the ability to adequately assess the effects of water transfers is severely limited (Appendix *VII.C*).

Hydrogeologic characterization
Characterization of aquifer structure and boundaries includes the following components:
1. aquifer geometry
2. degree of confinement
3. regional scale mapping of hydrogeologic boundaries, including:
   - major stratigraphic boundaries reflecting changes in depositional environment
   - single depositional units that restrict vertical flow over broad areas
   - bedrock structure
   - faults
4. local-scale mapping of hydrogeologic units to define the spatial variability of aquifer hydraulic and mechanical properties
5. delineation of aquifer boundaries using water chemistry characteristics (isotopes, major ion composition)

Water balance
The following components must be determined to estimate changes in the water balance as a result of a water transfer. These data need to be monitored at a regional scale to provide context for local scale studies.
1. Groundwater levels
2. Stream stage and discharge
3. Surface water deliveries
4. Net infiltration (precipitation + applied water – return flow – ET)

Land Subsidence
1. Paired aquifer compaction and discrete-interval, groundwater-level recording installations at groundwater extraction sites.
2. Land surveys coordinated with regional Geodetic networks.

Water quality
1. Ground water quality and temperature
2. Surface water quality and temperature

Socioeconomic Factors

1. Agricultural employment
2. Rural business sales and employment
3. Population size
4. Cropping pattern and acreage
5. Number and size of farms
6. Value of agricultural output
7. County tax collection and expenditures
8. Labor force and unemployment

RESEARCH

The research questions relevant to water transfers are an extension of questions that are relevant in the design of a groundwater monitoring and assessment program. Research into the following subjects would greatly improve the ability to manage groundwater in the unsaturated and in the saturated zone.

- Vadose zone processes and rates of recharge
- Interaction of regional- and local-scale processes
- Better methods to quantify interaction between ground and surface water
- Effects of climate variability on watershed processes
- Improved methods for storage, manipulation, and coordination analysis of data
- Land subsidence processes and predictive capabilities
- Scale variant hydrogeologic characterization
- Processes controlling water quality including the effects of increased rate and volume of extracted groundwater on water quality
- Effects of water transfers on persons, businesses or agencies that are not a party involved in the transfer (3rd party effects)

LINKAGES

Water Quality Program: The Water Transfers Monitoring Program refers to the Water Quality Program for quantitative information on stream flow and stream chemistry at all monitored sites in the Central Valley.

Storage and Conveyance Program (as well as the California Department of Water Resources—Division of Operations and Maintenance, Office of State Water Project Planning, and the U.S. Bureau of Reclamation, Central Valley Operations Office). The Water Transfers Program refers to these agencies for information regarding availability, and suitability of conditions for water transfer through surface-water conveyance facilities.

Ecosystem Restoration: The ecosystem restoration program must assess the ecological suitability of water transfer through the riverine and deltaic environments.

Water Use Efficiency Program: The Water Transfer Monitoring Program relies on information compiled under the Agricultural and Urban Water Conservation components of the Water Use Efficiency Program to assess future water supply and demand in the state to determine transfer needs, and to provide detailed land and water use information for water balance determinations and socioeconomic considerations.

Watershed Management Coordination Program: The effects of water transfers on riparian corridors, wetlands, and stream basins upstream of the Central Valley need to be monitored and assessed by the Watershed Management Coordination Program. The Water Transfers Program also relies on the Watershed Management Coordination Program for information on spatial and temporal input of precipitation to the Central Valley.

Various local, state, and federal agencies (Appendix *VII.C*): Socioeconomic information adequate to assess the economic effects of water transfers will have to be provided by agencies exterior to the CALFED program.