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DOE/EIS - 0138  
Volume IV, Appendix 7

**FINAL  
ENVIRONMENTAL IMPACT STATEMENT**

**SUPERCONDUCTING  
SUPER COLLIDER**

**Volume IV  
Appendix 7**



**December 1988**

**U.S. Department of Energy**

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DEPARTMENT OF ENERGY  
WASHINGTON, D.C. 20545  
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Washington D.C. 20585**

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1945

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This appendix has two primary sections: surface water and groundwater resource assessments. Each provides a discussion of the purpose, scope, and the methodology for impact assessment, followed by site-specific resource assessments. Notable changes or additions to this appendix from the DEIS are as follows:

- o Additional assessment and figures for potential floodplain encroachment by SSC facilities at the Colorado, Illinois, Michigan, North Carolina, Tennessee, and Texas sites.
- o Minor changes in direct and indirect water use estimates for the SSC at all seven sites. The most notable change is a small decrease in estimated operational industrial water use at both the campus and far cluster areas, while the estimated industrial water use at each of the remote service areas increased from 40 to 80 acre-ft/yr. Total estimated direct SSC water use did not change.
- o Clarifications and/or adjustments as regards the number of wells lost due to siting and construction of the SSC at each of the seven sites. The figures showing wells within the SSC footprint at each site (inappropriately labeled "wells potentially affected" in the DEIS) are not included as available well location data do not seem appropriate for map presentation.
- o Expanded discussion of the nature of the karst terrain at the Tennessee site. The potential for water level and groundwater quality impacts has been reassessed based on the existence of a more extensive shallow karst system than was assumed in the DEIS.
- o Additional water availability and water use data for all seven sites.

Direct and indirect water resource impacts are assessed for the SSC project during construction and operations as defined for the proposed action (Volume 1, Chapter 3 and Volume IV, Appendix 1). Preconstruction (confirmatory drilling, surveys, etc.) does not include any activities that could either singularly or cumulatively result in an inherent change to existing surface water or groundwater conditions at any of the sites. Consequently, no environmental impacts to surface water or groundwater during preconstruction are anticipated. Decommissioning is discussed in Volume IV, Appendix 3.

Background information and other information needed to perform assessments on water resources are included in Volume IV, Appendix 5, Affected Environment; Appendix 1, Engineering; Appendix 6, Earth Resources Assessments; and Appendix 10, Hazardous Source Terms and Waste Disposition.

The potential for radionuclide contamination of surface and groundwater resources is described in Appendix 10. The purpose of this categorization is to maintain a singular source for all radionuclide-related impact assessments. Descriptions of spoils disposal, dewatering wastewater, and other types of wastewater disposal are also included in Appendix 10. These descriptions provide the basis for the water resource related impacts of disposal activities that are briefly assessed and discussed in this Appendix 7.

Assumptions basic to the following impact assessments are:

- o Dust suppression during construction activities would be achieved by twice daily watering or through the use of chemical dust suppressants (wetting agents, hygroscopic salts, or surface crusting agents). These chemicals are standard industry chemicals for dust suppression and studies have shown minimum impacts on water quality (see EIS, Volume IV, Appendix 8, Section 8.2.2). These compounds are nontoxic and should not pose a ground- or surface-water contamination problem when properly applied.
- o There are no industrial point sources of pollutants associated with the project (sewage and cooling tower blowdown discharges are addressed).
- o Low-level radioactive, hazardous, and mixed waste would be disposed of at licensed sites per regulations and are not a potential source of water resource contamination.

The proposed project (direct) water supply sources may be surface water, groundwater, or both. The proposed project water supply sources are provided below.

- o Arizona - groundwater
- o Colorado - groundwater
- o Illinois - groundwater
- o Michigan - groundwater
- o North Carolina - surface water/groundwater
- o Tennessee - surface water/minor groundwater
- o Texas - surface water/groundwater

Water demands for secondary development induced by the SSC project (indirect) would be supplied by both surface water and groundwater sources at all sites. SSC-induced secondary development is described in EIS Volume IV, Appendix 14, Section 14.1.

## 7.1 SURFACE WATER

### 7.1.1 Purpose and Scope

The purpose of this assessment is to identify and evaluate impacts to surface water hydrology and flooding, water quality, and water use at the proposed sites from construction and operations of the SSC. The

actual impacts would vary both geographically and by season according to characteristics of the local areas surrounding each site.

"Surface water resources" refer to the occurrence, replenishment, movement, discharge, quantity, quality, and availability of water on the land surface. Surface water resources include streams, rivers, drainage channels, lakes, reservoirs, and ponds in the environs of the site.

The scope of the surface water resource assessments is to: 1) assess the magnitude of potential impacts on the surface water hydrology; 2) identify, evaluate, and recommend mitigation measures; and 3) assess the significance of the residual impacts. Impacts to surface hydrology have been evaluated at the site and regional levels. An assessment has been made for surface hydrology and flooding, water quality, and water use.

The scope of surface water resource impact assessments includes increased surface runoff, drainage pattern change, floodplain encroachment, increased surface erosion, increased channel erosion, altered water quality, and increased surface water use. These areas of impact are interrelated in both the factors influencing them and in their influence on each other.

## 7.1.2 Technical Approach and Methodology

### 7.1.2.1 Conceptual Basis

#### A. Level of Resolution

##### 1. Temporal

The analysis and evaluation focuses on impacts during SSC construction and operations. Construction would begin when the first site clearing activity was initiated for any of the surface facilities around the ring, including preparation for excavation at cut-and-cover sections. Operations would begin when all construction was completed and would continue until active use of the facility ceases. Impacts to water use, surface water hydrology, flooding, and water quality would continue until some time during decommissioning when the facilities causing these impacts were removed.

There are seven potential impact categories identified for surface water resources. Two of these, surface erosion and drainage network modifications, would have impacts only during construction. Three others - surface water runoff, floodplain encroachment, and channel erosion - would have impacts initiated during construction that could continue throughout operations. The final two - surface water quality and surface water use - would have impacts that could occur during both phases but there are processes unique to each phase that would cause the impacts.

##### 2. Spatial

Project impacts are assessed at both site and regional levels. The surface area immediately adjacent to each project facility, and for a

distance of not more than 1 mi downstream, defines the site level assessments. Regional impacts are defined for the area from where the channels cross the ring, downstream to where these channels join the major drainage basin channels.

## B. Impact Assessment Process and Terminology

For both construction and operations, impacts are defined as project-induced changes to the existing environment and projected future trends, where appropriate.

For surface water hydrology, flooding, and water quality assessments, project-induced changes are compared with current conditions in the project area. For water use assessments, project needs are compared with the current system capacity and the projected future trend in water needs in the affected region, where available.

The impact assessment process involved four stages. First, the available data were assembled concerning the site environment and project activities. Second, the data were evaluated and the impact magnitude was predicted. Third, applicable mitigation measures were considered, and their expected effectiveness in reducing related impacts was evaluated. Fourth, the significance of residual impacts remaining after application of any recommended mitigation was assessed and impacts were characterized as short-term, long-term, or irreversible. More detailed descriptions of the type of data used and the evaluation process are given for each impact category in Section 7.1.2.2.

### 1. Impact Mitigation

Impact mitigations are construction or operations activities, procedures, or methods whose application would reduce the magnitude of project impacts. Some mitigation measures are expected to be part of final project design or part of standard engineering and construction practices.

Other mitigation measures are suggested for further evaluation in final project design. Standard and suggested SSC project-specific mitigations are described in Section 7.1.2.2 below.

### 2. Impact Significance

The residual impact is considered significant if one or more of the following conditions is likely to occur after the application of appropriate mitigation measures:

- o A Federal, state, or local regulation governing water quality standards, water appropriation, stormwater management, erosion and sediment control, or floodplain encroachment would be violated.

- o A major change in water use patterns, water supply system capacities, or natural streamflow volumes would be necessary or would result from project activities.
- o Damage to improved properties, public utilities, transportation facilities, or surface water resources would occur.

#### 7.1.2.2 Assessment Methodologies

Seven categories of potential impacts to surface water resources during construction and operations are identified in this appendix. Data used to assess these impacts vary in amount and quality. The sources of data include Federal, state, and local agency files and publications; other published data; and SSC siting studies. Non-governmental data sources are used only as necessary to complete data sets. Specific data sources, impact assessment methods, and mitigation measures are described below, by impact type.

##### A. Surface Runoff

###### 1. Impact Assessment Method

Activities involved with construction of buildings, roads, and parking facilities in the campus and injector areas would disturb those areas and increase the impermeable surface area. Similarly, construction of other facilities around the ring (such as service buildings, collision halls, access halls, staging buildings, exit-vent shafts, roads, and utilities) would create impermeable surface areas, though at a much lower density than the campus facilities. Surface runoff would increase from these areas, as would the discharge to drainage channels downstream from each project facility. The net impact would be to increase the peak discharge of streams draining the disturbed area. On a regional scale, housing construction for SSC-related personnel and their families would produce additional impervious surface areas. This construction may be concentrated in specific geographic areas. Factors affecting the magnitude of impacts caused by runoff increases are: the amount and type of changed land use or land cover, the amount of rainfall at the site, and the current hydrologic regime of the basin (its basin lag, runoff response, etc.).

Three general types of data were used to assess impacts to surface runoff. These include 1) the estimated area of disturbed land and its planned land use (especially impermeable areas); 2) the yearly rainfall amount, and whether rainfall occurs throughout the year or only in certain seasons, including the likelihood of intense rainfall events (thunderstorms, hurricanes, etc.); and 3) the current hydrologic regime of streams in the project area and how responsive the area is to rainfall runoff.

Impacts were assessed by comparing estimated disturbed areas to total watershed area. The estimates of areas disturbed were developed for EIS Volume IV, Appendix 1, Engineering. Where existing surface conditions

do not differ greatly from the conditions expected after site development, impact was judged to be negligible. If rainfall amounts are on the average small, and intense rainfalls unlikely, even a large surface disturbance would have a negligible impact to surface runoff. A hydrologic regime affects surface runoff by how well or poorly increased runoff is translated into peak stream discharges. If the site has low relief and poor drainage, it takes a larger surface change to cause a similar peak increase than in a well-drained site.

## 2. Impact Mitigation

Impacts related to surface runoff could be reduced in some instances by avoidance of more sensitive areas (e.g., steeper slopes) during construction.

Increased runoff could be mitigated with the construction of retention basins located at the downstream end of the construction area and before flow discharges into the local drainage channel. These basins would collect surface runoff from the construction area and temporarily retain the flow while releasing a reduced amount to the local drain, to generally conform with flow magnitudes associated with preconstruction conditions. If constructed of sufficient size, these basins could even reduce flood flows to a magnitude that would be less than that of preconstruction conditions. Additional measures include using porous pavement, infiltration trenches and basins, surface detention, and unlined drainage ditches in place of curbs and gutters.

Detention basins are generally necessary only for relatively large-scale construction activities such as the campus area. For smaller construction activities, such as the various project facilities located around the ring, construction of retention basins may not be practical or necessary. The assessment indicates where these mitigations would be considered as part of final project design.

## B. Drainage Network

### 1. Impact Assessment Method

To protect open excavations, such as cut-and-cover tunnel construction, from surface runoff and existing stream channels, during construction a system of diversion levees and channels would be employed. The levees intercept natural flow of runoff from the upstream watershed, and direct it around the open excavation. This would concentrate flow along the upstream side of the levee and collect the flow from various drainage channels and watershed areas. The artificial channels would divert this flow to a nearby drainage channel that would safely convey the runoff across the collider ring alignment to a downstream outlet channel. When diversion of runoff from adjacent drainage channels is combined with the normal runoff in that channel, substantial increases in the discharge of the receiving channel can occur. Factors affecting the magnitude of impacts caused by drainage modifications are the percent increase or decrease in the drainage area, change in channel slope and distance, and the configuration of the receiving channel.

Data used in assessing impacts to drainage networks were derived from the site engineering assessment presented in Volume IV, Appendix 1, Appendix 10 (Hazardous Source Terms and Waste Disposition), and Appendix 14.2 (Infrastructure) for the location of cut-and-cover excavation of the tunnel and experimental halls, new roads, sewer lines, water lines, and gas lines. Topographic maps provided data on drainage areas, existing or proposed channel slopes, current drainage network configurations, and downstream structures that could be impacted.

The necessity for modifying a drainage network was identified using preliminary site plans and topographic information. If a modification was necessary, an assessment was made as to the extent of the change in the drainage network, and the potential for substantially increasing the contributing drainage area to specific channels. A significant increase was defined as a 20 to 30 percent change to the watershed area of a drainage channel. If such an increase in watershed area appeared unavoidable, then the presence of downstream structures which would be affected by increased flows (or would combine with them to worsen the problem) was assessed.

## 2. Impact Mitigation

Changes in drainage patterns resulting from the construction of diversion levees and channels would be mitigated by modifying the construction schedule and approach, or by relocating surface facilities to minimize the amount of drainage area affected. In areas where levees would be used to protect open excavations, the reach of excavation could be shortened to minimize the necessity for major or large-scale diversions. For areas of significant surface construction, the construction activities could be concentrated in small, confined areas. Before moving to a new area for facility construction, the drainage features and patterns in the initial area would be restored.

Where the above modifications are possible or practical, retention basins could be constructed as described under mitigation of surface runoff. Either one large basin could be constructed in the diversion channel where it discharges into an existing local drain, or several smaller-sized basins could be constructed in series. In either case, the flow from the diversion could be diminished to the extent that it produces only a minimal increase in discharge to the existing local drain. The assessment indicates where these mitigations could be considered as part of final project design.

## C. Floodplains

### 1. Impact Assessment Method

Under Executive Order 11988, "Floodplain Management," Federal agencies must consider the protection of floodplains in decision-making processes. DOE regulation 10 CFR 1022 (Compliance with Floodplain/Wetlands Environmental Review Requirements) provides the procedures that the DOE follows to assure adequate consideration of floodplains and wetlands (wetlands are discussed in Volume IV, Appendix 11).

Accordingly, this EIS, including the Water Resources Assessments (Appendix 7), the Engineering Description (Appendix 1), and other sections (such as Volume I) constitutes the floodplain assessment including the project description, location, analysis of impacts, and suggested mitigations.

The collider layout for the seven site alternatives is based on a generic design described in the Invitation for Site Proposals. Because of the requirement to adopt a standard layout, some site proposals contain fee simple land areas in existing floodplains. In considering a final, site-specific design, facilities currently proposed in floodplains would be relocated to exclude floodplain encroachment to the maximum extent possible. To protect any facilities which must be constructed in floodplain areas from flooding, the facility could be either elevated or have levees constructed around it. This would create floodplain encroachment that could raise the flood level in the adjacent channel or direct flood flows into areas not previously reached because of a loss in floodwater conveyance. Buildings, flood protection measures, bridge abutments, and roadway fills with culverts are all examples of floodplain encroachments.

Factors affecting the impacts caused by floodplain encroachment are the width of the floodplain, the potential width of the encroachment, and the existing hydrologic regime.

The data used to assess such floodplain impacts were the site engineering assessment from Appendix 1, and the utilities and transportation description in Appendix 14; Federal Emergency Management Administration (FEMA) Flood Insurance Rate Maps; U.S. Geological Survey (U.S.G.S.) Flood Hazard Area Maps; and topographic maps.

The process of assessing impacts involved identifying the potential location of a facility in or near a 100-yr floodplain according to FEMA flood insurance rate maps. If no data existed for a 100-yr floodplain, general flood hazard areas were considered. Impact magnitudes were qualitatively assessed based on how close the proposed facility would be to the stream or floodplain, and whether its size would represent a major encroachment (more than 25 percent of the floodplain width). Flow regime was considered only if encroachment was likely, and it then was used as a secondary factor.

## 2. Impact Mitigation

The most effective mitigation for floodplain encroachment impact is to locate the facility outside the identified or assumed floodplain. A second mitigation is to construct levees along the channel in any areas where water level increases are expected. The assessment identifies cases where these mitigations would be considered further as part of final project design. Given the potential for relocating surface facilities to avoid floodplain encroachment, the impacts described in this EIS are considered to be the maximum. Careful design and site layout will reduce impacts at the selected site to the minimum achievable.



## D. Surface Erosion

### 1. Impact Assessment Method

Construction activities would remove vegetation covering the soil and this soil disturbance, in conjunction with increased runoff from the site, could promote surface erosion and increase the discharge of sediments to nearby drainage channels. Sediments could accumulate in channels, potentially reducing their flood-carrying capacity. On a regional scale, housing development for the additional SSC population would also cause vegetation removal and soil disturbance. Additional aggregate supplies necessary for the SSC construction and any additional housing development would come from existing sources. Aggregate mining generally involves substantial surface disturbance and erosion potential. Stockpiling and/or disposal of materials removed during tunneling activities would provide another source of potential surface water impacts from erosion (increased stream turbidity, influx of leachate). Spoils disposal alternatives are identified in Appendix 10, Section 10.2.3. Impacts to surface water from erosion of spoils piles are discussed under the sections dealing with water quality.

Factors affecting the magnitude of impacts from surface erosion are the topography, the erodibility of soil and rock present in the disturbed area, the size of the disturbed area, the amount of rainfall at the site, and the nearness of disturbed lands to stream channels.

Data used to assess this impact were the SSC engineering description included in Appendix 1, including the known areas of surface disturbance such as cut-and-cover operations (for construction of underground facilities) and the known surface development areas like the campus, the service and intermediate access areas, and the buried beam access areas. Additional data included topographic maps for slopes and stream channel locations, and rainfall information as used in surface runoff assessments.

To assess impacts on surface erosion caused by SSC facility construction, the amount of disturbed area was estimated by watershed and compared to the total drainage area of that watershed. Topographic slopes were characterized as low, moderate, or steep near the areas of disturbance. Proximity to stream channels was defined as within 1,000 ft of the channel. Rainfall amounts and the frequency of occurrence of thunderstorms was also considered. All of these factors were considered together, and their cumulative effect qualitatively evaluated to assess impact magnitude.

### 2. Impact Mitigation

Surface erosion impacts could be reduced by the following mitigations: 1) scheduling construction activities to reduce the amount of disturbed areas at any point in time, 2) maintaining natural vegetative buffer strips between disturbed areas and surface water bodies, 3) scheduling clearing and construction, where practical, to avoid relatively erodible soils during wet seasons, 4) collecting runoff from disturbed areas by

temporary drainage ditches and diverting such runoff to sedimentation basins, 5) using runoff retarding devices such as hay bales to reduce flow velocity and, consequently, erosion, and 6) restoring disturbed areas to desired topography and establishing locally adapted vegetation as soon as possible. As necessary, following runoff events sediment would be removed from the catchments so that the catchment would be ready to retain eroded material from another runoff event. The assessments indicate where these mitigation measures would be considered as part of final project design.

## E. Channel Erosion

### 1. Impact Assessment Method

Construction activities for the SSC facility would remove vegetation and disturb soils (clearing and grubbing). Once constructed, surface facilities have more impervious areas than now exist in the site location, with rooftops, roads, and parking lots. Such changes to the land cover would promote increased surface runoff and peak flows downstream from the disturbed area, thus changing the hydrologic regime. This could, in turn, affect channel stability and cause bed and/or bank erosion, hence, channel enlargement. The increased suspended sediment load would affect stream water quality, and deposition downstream from areas of channel enlargement.

Factors affecting the magnitude of impacts to channel erosion are the percent increase in flow volume, and the type of bed and bank material in the channels (i.e., its potential erodibility).

Data used to assess channel erosion impacts included all sources cited for surface runoff changes, and observations made of stream channel bed and bank material during site visits. The assessment process started with the conclusions drawn about impacts expected on surface runoff. Channel erosion is a direct result of increased runoff and channel flow, and the strength of channel materials in resisting increased forces. However, if runoff increases are not expected to be measurable, it is unlikely that channel erosion would be measurable. If channels are mainly bedrock, even significant increases in runoff and peak flow would be unlikely to cause measurable channel erosion.

### 2. Impact Mitigation

The potential for increased channel erosion could be minimized by using the retention basins and sediment traps described for surface erosion impact mitigation.

The potential for channel erosion can also be mitigated using various types of armoring material or by constructing grade-stabilizing structures in the channel. Common types of armoring material include: concrete lining, rock riprap, gabions, various types of felt material, and vegetation. Grade-stabilizing structures can elevate the channel bottom at specific locations, reduce the channel slope, and thereby reduce the

flow velocity to non-erosive magnitudes. Energy dissipators can accomplish much the same effect. The assessments indicate where these mitigations would be considered as part of final site design.

## F. Water Quality

### 1. Impact Assessment Method

Potential nonpoint source water quality impacts during construction would be caused by suspended sediment derived from surface or channel erosion or by other material picked up by surface runoff. This would be a direct result of the construction activity, including tunneling and disposal of spoils material. General surface or channel erosion is not expected to contribute any unusual materials, just higher-than-normal turbidity and nutrient levels. A potential exists for other constituents to be derived from leachable materials in the tunnel spoils, as discussed in Appendix 10. Increased wastewater production during operations and treatment resulting from on-site activities and off-site development is discussed in Appendix 14, Section 14.2.2, Utilities. Water quality impacts could result from these increases, and the impacts from these point sources are considered in the following assessments.

Factors affecting the magnitude of water quality changes are the amount of increased erosion from SSC construction and operations, the chemical constituents in the local soils or rocks, the constituents in runoff from the developed areas of the SSC, the amount and frequency of local runoff, the volume of dewatering effluent expected, and the expected wastewater treatment plant effluent increase because of SSC activities.

The data used in assessing water quality impacts include much of what has already been described under surface runoff impacts and surface and channel erosion impacts. Additional data sources include: 1) descriptions of facility wastewater treatment requirements, secondary wastewater treatment needs, and the description of spoils disposal, all in Appendix 10; 2) general information on nonpoint source pollution from developed areas; and 3) available water quality data for receiving water at each site.

The process of assessing water quality impacts involved consideration of four potential pollution sources: 1) nonpoint sources such as erosion of surface and channel sediment, and constituent wash-off from impervious surfaces; 2) dewatering effluent from tunneling activities; 3) erosion of or leachate from tunnel spoils; and 4) wastewater treatment plant effluent increases. Nonpoint source assessments started with the expected impact evaluations for surface runoff, surface erosion, and channel erosion at a site. General consideration was given to average and intense rainfall at each site and expected nonpoint source amounts from suburban-type developments. The impact magnitude was then qualitatively assessed. Dewatering was assessed after comparing the rate of water expected and its quality, with the quality and volume of receiving waters. Erosion of spoils was considered using the same factors and the same processes as were used for surface erosion assessments. Leachates

from spoils disposal alternatives were also considered using a similar assessment process. Most sites proposed multiple disposal alternatives. These were generalized by type and each type was considered separately. Wastewater treatment effluent increases were compared, when available, with existing loads on receiving waters and the receiving water quality. The analyses assumed that wastewater would be produced in each site vicinity at an average rate of 100 gal/d per capita. Impact magnitude was assessed if the expected increase in effluent load was a large portion of the existing load on any single receiving water body, or if this load was equivalent to (or greater than) the normal load of the receiving stream.

## 2. Impact Mitigation

Potential changes in water quality from nonpoint sources could be mitigated by any of the measures described above for mitigating increased runoff, changes in drainage patterns, surface erosion, and channel erosion. These measures include modified construction practices, accelerated revegetation, construction of retarding basins and debris traps, and stabilized channel banks and bottoms. Specific water treatment options exist for point sources, such as wastewater, dewatering effluent, leachate, and cooling tower blowdown. These options could be employed on a case-by-case basis after site characterization has adequately defined the scope of the impact and potential mitigations. The assessment identifies cases where mitigation would be considered further in final project design.

## G. Surface Water Use

### 1. Impact Assessment Method

Expansions or other upgrades to local public water supply systems using surface water sources may result from a primary use at the site, or from a secondary demand induced by in-migration for the project and any indirect population growth. Such secondary demand would affect communities in the immediate site vicinity as well as at some distance from the site. Primary construction water uses are different from primary operations water use; therefore, impacts caused by the latter are discussed separately for each state, in the sections on operations. Factors affecting the magnitude of impacts caused by increases in water use are the water requirements for different construction and operations activities, per capita water use in the area, and expected population increases by community or water system.

Data used to assess impacts included projected population increases related to the project, existing and projected surface water use, and existing water supply, treatment, and distribution system capacities. Current use and available excess water were also essential data used to assess project impacts. Expected construction and operations water

requirements were established using site engineering evaluations. Population numbers were converted to water requirements by applying average, state-specific, per capita water use data derived from Solley et al. (1983).

Impacts to water use were assessed by comparing potential increased water supply requirements with existing community water use, the existing system's capacity, and its planned capacity. Potential new water supply requirements include both primary water use at the SSC facility and secondary demand induced in the region. Population in-migration was generally projected only at the county level rather than by community (see Appendix 14); thus impacts were qualitatively evaluated assuming that the increased water use is distributed throughout communities in the affected counties. Impacts were considered significant if the expected increase would be a large percentage (>20 percent) of the available excess.

## 2. Impact Mitigation

No effective mitigation measures are available for the direct physical impact of expanding a water treatment and distribution system. The need for expansion could be delayed by implementing water-saving measures. However, the effectiveness of these measures would be dependent upon their acceptance by the users. Most of the water use for construction, and some of the use for operations, would be consumptive, with little or no opportunity for reuse. This water use would be largely unmitigable. Impacts to a specific water supply source could be mitigated by developing an alternative source, if any are available.

### 7.1.3 Resource Assessments

Location of the SSC at any of the proposed sites would result in increased water demands locally during both construction and operations. Estimated on-site construction and operations water uses associated with the project are summarized in Table 7-1. The portion of this estimated total use to be provided by surface water is defined in the individual site resource assessments and is used as a source term in assessing impacts. The construction use given in the table includes water for:

- o Workers on site (potable water)
- o Concrete
- o Soil compaction
- o Dust control
- o Landscaping
- o Access roads
- o Spoils areas
- o Contractors' areas (equipment washing, etc.).

Construction water use would vary somewhat among sites. However, construction water use estimates are not refined enough at this time to quantify a site-by-site variation. A single set of water use estimates is given to evaluate water resource impacts at all sites.

Table 7-1

**ESTIMATED ON- AND OFF-SITE WATER USE  
DURING SSC CONSTRUCTION AND OPERATIONS<sup>1</sup>**

Water Use Category	Construction Water Use (acre-ft/yr)							Operations Water Use (acre-ft/yr)	
	1989	1990	1991	1992	1993	1994	1995		Total
Construction <sup>2</sup>	5	39	87	88	68	46	10	343	--
Operations <sup>3</sup>									
Potable <sup>4</sup>	--	--	--	--	--	--	--	--	400
Industrial									
Campus	--	--	--	--	--	--	--	--	995
Far cluster	--	--	--	--	--	--	--	--	140
Service areas (total)	--	--	--	--	--	--	--	--	<u>640</u>
Total Industrial	--	--	--	--	--	--	--	--	1,775
Off-site <sup>1</sup> (average)	<u>235</u>	<u>830</u>	<u>1,515</u>	<u>1,560</u>	<u>1,345</u>	<u>1,430</u>	<u>1,210</u>	<u>8,125</u>	<u>1,120</u>
TOTAL	240	869	1,602	1,648	1,413	1,476	1,220	8,468	3,295

1. Estimated off-site water use associated with the project varies among the sites. An approximate average for the seven sites is presented here. Tables listing site-specific values are included in the individual site assessments in Appendix 7.
2. Includes potable water for workers on site and water for concrete, compaction, dust control, landscaping, access roads, spoils areas, and contractors' areas; amounts are assumed to be the same for all sites.
3. Operations water use is assumed to be the same for all sites.
4. Potable water for campus area only; potable water for far cluster and service areas assumed to be bottled water.

Source: Off-site water use estimates derived from population in-migration estimates converted to water requirements by applying state-specific per capita domestic water use values, derived from Solley et al. (1983).

Operations water use is shown as an annual value assumed to remain relatively constant. This use is broken down into potable and industrial water. Potable water use is estimated for the campus area only. The limited amount of potable water use at the far cluster and the eight distributed service areas is assumed to be provided either by bottled water or piped through the tunnel from the campus area.

Estimated off-site water use is also presented as an average in Table 7-1 because there is a substantial variation in this indirect water use among the sites. More detailed site-specific estimates are tabulated within the individual site resource assessments, and these estimates are used for impact evaluation.

### 7.1.3.1 Arizona

#### A. Surface Runoff

The Arizona site is located in a relatively undeveloped area with cover conditions typical of a desert environment. Total land disturbance anticipated for this site (SSC facilities, roads, and utilities) is about 2,155 acres. The campus and injector complex would disturb about 500 acres in combined surface construction and excavation for the injector and booster tunnels and experimental halls. About 280 acres would be involved in the cut-and-cover construction for the injector and booster tunnels. This would include less than 100 acres of actual excavation, with the rest for stockpiling, staging, site access, and other associated earthwork and construction disturbance. All of the campus/injector area falls within the Waterman Wash drainage basin (Figure 7-1).

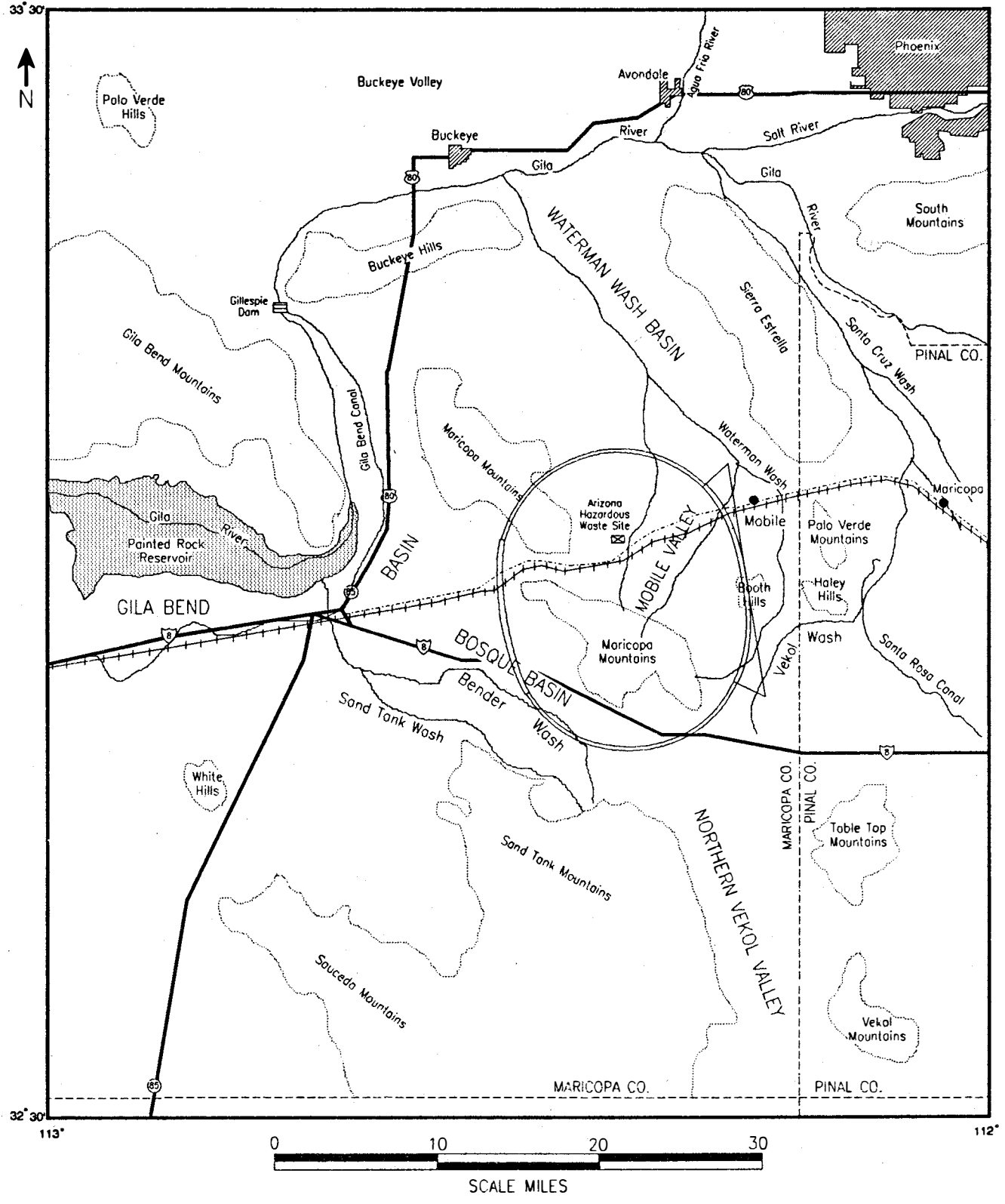
Other areas of disturbance are scattered around the ring in parcels generally no larger than 5 to 10 acres and, in most cases, much smaller. One exception is tunnel construction using cut-and-cover methods in Mobile Valley, north of the campus along the ring, where about 215 acres would be disturbed. This tunnel excavation and associated disturbances would be narrow and long (300 to 500 ft wide by 6 mi) and because of its shape should not cause significant increases to runoff. No more than about 1 mi of excavation would be open at a time, which also would lessen the impact. The excavation would have a more important impact on the drainage network, as discussed in Section 7.1.3.1.B. The other large area is a projected 135-acre disturbance for an evaporation pond to be located somewhere within the ring.

The major surface disturbance would be located in the Waterman Wash drainage basin, where the campus and injector complex, utilities, and all of the cut-and-cover tunnel excavation comprise about 850 acres (1.33 mi<sup>2</sup>) of the watershed. The west branch of Waterman Wash upstream from the point of intersection with the ring alignment has a drainage area on the order of 130 mi<sup>2</sup>, so the disturbance would be only about 1 percent of the watershed. Because this is such a small percentage of the watershed, and because the disturbance is located on the divide between Waterman Wash and the adjoining watershed, it is unlikely to have a large impact on surface runoff. In addition, annual rainfall is less than 10 inch/yr and single heavy rainfalls can amount to almost half this [4 inches for a 6-hr rainfall with a 100-yr return period (U.S. Weather Bureau 1961)]. When rainfall occurs as intense storms, surface permeability is less important in contributing to runoff. Also, low permeability of desert soils is not likely to be changed much with surface disturbance. Therefore, surface disturbances are not likely to substantially change surface runoff characteristics or runoff amounts, and impacts to surface runoff should be negligible.

For the same reasons, other less extensive disturbances from the SSC construction are unlikely to cause measurable impacts to surface runoff. This includes all construction activities for the facility and for the transportation and utility access that would be provided.



Figure 7-1  
HYDROLOGIC FEATURES - ARIZONA SITE



## B. Drainage Network

Approximately 22 percent of the main ring, all the experimental halls, and the entire injector complex are scheduled for cut-and-cover construction. Because of the flooding potential of desert washes and bajadas, this operation would require levees and diversion channels along the upstream side of the excavations to collect and divert all flood flows around the excavation. During both construction and operations, diversion channels may also be used upstream from the campus to divert flow and reduce the need for a major internal drainage system. These diversion systems would collect flood flows from numerous channels and direct the discharge to a single channel. In the campus area, the injector complex, and that portion of the collider ring scheduled for cut-and-cover construction, this could be a measurable impact that would be most severe in the area of open excavation south of the Southern Pacific Railroad. Discharge must cross the railroad from south to north in culverts, and the concentration of flows from numerous upstream drainage channels might exceed the culvert's flow capacity, causing the discharge to flow laterally seeking other culvert crossings or flowing overtop the railroad embankment. This latter occurrence could potentially damage the embankment and railbed.

While the Arizona site has limited rainfall, significant precipitation amounts can occur in a single event, and 50- and 100-yr events can produce 3.5 inches and 4.0 inches of rainfall respectively in a 6-hr period (U.S. Weather Bureau 1961). Generally, low permeability of desert surfaces also contributes to large runoff amounts from intense storms. Flash flooding is likely to occur after heavy precipitation. Even though such floods are rare on any given watershed, their occurrence causes severe results. The use of standard stormwater management mitigation measures such as detention and retention basins may be unfeasible options because of the unpredictability in location of occurrence. Impacts due to stormwater diversion can be mitigated by scheduling construction to limit the area of a watershed that is disturbed at any one time. Prompt regrading and restoration of excavations will return flow conditions to predisturbance characteristics. Also, if this site is selected, mitigation by providing additional drainage capacity through the railroad embankment would be considered during final SSC design.

No other significant drainage diversion would be required at other facilities around the ring, so their impact from drainage network modifications would be negligible. Regionally, even the railroad embankment drainage problem would cause negligible impacts when considering the larger Waterman Wash drainage.

## C. Floodplains

The Arizona site is not situated within or adjacent to any major river system or floodplains. No FEMA Flood Insurance Rate Maps have been prepared for Maricopa County in the area where the SSC project site is proposed. This is an indication that flooding in this area has limited damage potential, primarily because there are few man-made structures.

The project facilities would be located in areas that experience sheet flow, but would be outside any area that would be considered floodplains. Therefore, there would be no expected impacts to or encroachments on floodplains. (The DOE has begun informal consultation with the Los Angeles District Corps of Engineers concerning floodplain encroachment.)

#### D. Surface Erosion

Construction activities on fragile desert soils, or protective desert pavement can create the potential for substantial erosion problems. This, of course, is limited by the infrequent nature of rainfall in the desert, where a 3.5-inch to 4.0-inch rainfall may occur on the average only once every 50 to 100 years. It is possible that the entire construction period could go by without a significant event. But if a large storm occurred, much heavier than normal erosion would probably result. Measurable surface erosion impacts could occur in the campus area, injector/booster complex, or open tunnel excavations if a major rainfall event occurred during construction. This impact would be significant, although short-term at the site level. At the other areas of construction activity around the ring, disturbances would be much smaller and erosion impacts more easily mitigated to negligible levels. Mitigation measures such as diversions around heavily disturbed areas, use of surface protection, and staging construction activities such as excavations in smaller intervals could help reduce this impact, and would be considered as part of final site design.

#### E. Channel Erosion

Any increased runoff associated with diversions around areas with cut-and-cover excavation and the campus parcel would produce measurable impacts to channel erosion in those channels that received increased runoff. These impacts would be most severe in the area south of the Southern Pacific Railroad, where the sediment would be deposited upstream from drainage culverts. This impact is also highly dependent on the rainfall frequency. Because most streams in the area are ephemeral, it takes a storm with a return period of at least 10 years to cause noticeable stream channel erosion. If such an event were to occur, it could represent a significant although short-term impact. Some mitigation (e.g., grade stabilization, energy dissipating structures, and channel protection measures) can reduce these impacts, although they may still be measurable. Such mitigation measures would be considered as part of final site design.

Other facilities around the ring represent small areas (<50 acres) or linear areas for utilities that are not likely measurably to affect surface runoff or, as a result, channel erosion. In addition, because most storms causing erosion are infrequent large rainfalls, the change in runoff due to surface disturbance would be minimal. During large rainfalls a significant percent of the rainfall becomes runoff, and changes to land surfaces would minimally affect the runoff amount. Therefore, channel erosion impacts caused by other facilities should be negligible.

## F. Water Quality

Potential nonpoint sources of pollutants are surface and channel erosion, and pollutant washoff. Potential point sources are leachate from tunnel spoils, industrial wastewater, and treatment plant effluent. Surface water flow is a very transient phenomenon in this part of Arizona, usually occurring only during the largest of the infrequent rainstorms. During these periods surface water is heavily loaded with sediment and, although there have been no water quality analyses made of this ephemeral flow, it may also be high in dissolved solids. Since there is a limited amount of natural surface water in the area, none of the project construction or operations activities would impact the quality of existing surface waters because of the quality of site runoff.

Wastewater treatment for the Arizona site is described in Section 10.3.3.1 of Appendix 10, and industrial wastewater in Section 10.3.3.3, also in Appendix 10. On-site wastewater treatment would be by a new tertiary treatment plant for the campus area. Discharge from this plant would require an NPDES permit if it is outlet to the surface drainage system. If this is the case, the quality of discharge water from tertiary treatment should cause no impact to existing surface waters, but could create a new surface water body. Discharges to a holding tank, pond, or evaporation pond with no outlet to the surface drainage network would have no impact on surface water quality. Cooling tower blowdown water would be transported to a centralized evaporation pond, with no outlet to surface waters. There would be no expected leachate to surface water from spoils, as spoils are planned for disposal in an abandoned mine with no surface outlet.

SSC-induced population increases in the Phoenix area are expected to be only about 0.4 percent more than projected without the SSC. Wastewater discharges would thus be only minimally affected.

No dewatering is expected to be necessary for the tunnel boring activities at this site, because the tunnel is above the local water table.

## G. Surface Water Use

### 1. Construction

The proposed construction water supply for the Arizona site is groundwater. General facility water use has been estimated for the period 1989 to 1995, and is included in Table 7-1. Off-site water use has been estimated by county and is presented in Table 7-2. No direct on-site use of surface water is proposed for this site during construction.

Potential off-site surface water use would come from any in-migration to the Phoenix area. The Phoenix municipal water supply system provided 304,872 acre-ft of water to municipal and industrial users in 1985, 229,294 acre-ft (or 75 percent) of which was surface water obtained through the Salt River Project (Welty 1988).

Table 7-2

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
DURING SSC CONSTRUCTION AND OPERATIONS IN ARIZONA<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)							Water Use During Operations (acre-ft/yr)
	1989	1990	1991	1992	1993	1994	1995	
Phoenix Central	250	850	1,520	1,540	1,300	1,360	1,125	910 - 1,205
Rest of Maricopa County	5	25	45	50	40	45	35	30 - 40
Pinal County	70	270	485	505	445	485	425	340 - 445
Pima County	<u>40</u>	<u>115</u>	<u>215</u>	<u>205</u>	<u>160</u>	<u>160</u>	<u>115</u>	<u>95 - 130</u>
TOTAL	365	1,260	2,265	2,300	1,945	2,050	1,700	1,375 - 1,820

1. Estimated domestic water use is based on population projections multiplied by a factor of 155 gal/d/capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Arizona. The estimates do not include water delivered for industrial and commercial use

Additional population increases in the Phoenix area from in-migration are expected to increase water use during the SSC construction, with the peak use of 1,540 acre-ft occurring in 1992. This represents less than 1 percent of the current annual system use, and less than 1 percent of the 1985 annual surface water use. This represents a minor increase in surface water use and should cause a negligible impact to surface water sources.

Outside the Phoenix area, municipal and industrial water needs are met by pumping groundwater (Welty 1988) and thus will have no impact on surface water uses.

## 2. Operations

Planned water supply for the SSC facility operations is groundwater but Central Arizona Project (CAP) water is an alternative or backup source for all or a portion of industrial water requirements during operations. For purposes of impact analysis, a groundwater source is assumed. There would be no impact to existing surface water use in the area from on-site water use. Potential off-site surface water use increases would occur only in Phoenix where water supplies are primarily from surface water sources. During SSC operations, expected off-site water uses in the Phoenix area would be from 910 to 1,205 acre-ft/yr. This is less than 1 percent of the 1985 water use in Phoenix, which was mostly surface water. This represents a small percentage increase above current surface water use, and should cause a negligible impact to surface water use in the Phoenix area during SSC operations.

### 7.1.3.2 Colorado

#### A. Surface Runoff

The Colorado site is characterized by low rainfall (less than 16 inch/yr), cold winters, and moderate summers. The proposed SSC site is located in a predominantly agricultural area typical of the High Plains region, with very little urban or suburban development. The site and regional areas associated with hydrologic impacts are shown in Figure 7-2.

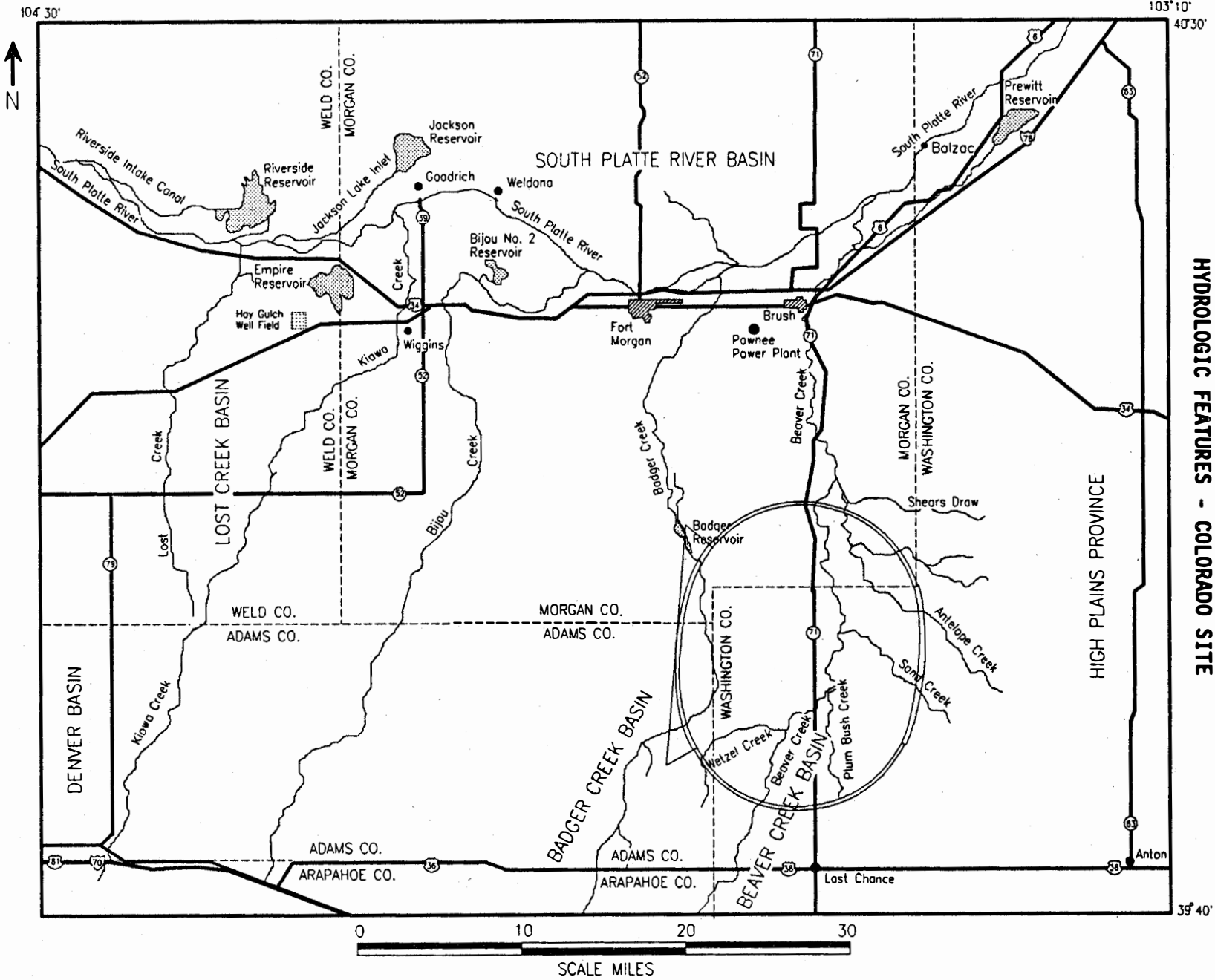
Total land disturbance for the Colorado site (SSC facilities, roads, and utilities) is about 3,400 acres. The campus and injector areas would disturb about 500 acres of land, including both surface construction and open excavation for the booster and injector tunnels and experimental halls. There would be about 280 acres of excavation for the booster and injector tunnels, including areas for stockpiling, staging, access, and other earthwork and construction. This disturbance would be in the watersheds of two ephemeral tributaries that drain from west to east into Badger Creek. These watersheds are each less than 10 mi<sup>2</sup>. The largest disturbance would be about 280 acres in the drainage containing the injector complex, which would be less than 10 percent of the tributary's drainage area. Mitigation of runoff increases by stormwater detention and retention ponds could further reduce this impact, and would be considered as part of final project design.

While total annual rainfall averages under 16 inch/yr, thunderstorms occur on the average of about 50 times per year. The higher return period storms (the 10-, 50-, and 100-yr events) can drop 2.5 inches, 3.2 inches, and 3.9 inches, respectively (U.S. Weather Bureau 1961). Thus, the infrequent storms would bring heavy rain and high runoff regardless of surface disturbance. Considering the climate, the disturbed areas of these watersheds, and mitigation, the impact to surface runoff from the campus area and the injector/booster area disturbances would be negligible.

Other disturbed areas around the facility, and the transportation and utility access corridors to the facility, would represent a sizable land area. Fortunately, these disturbances would be spread over a large area and a number of watersheds, covering only a small percentage of any one watershed. Combined with the low rainfall of the area, these disturbances would have only a negligible impact on surface runoff.

#### B. Drainage Network

Construction areas with open excavation, such as the injector and booster tunnels, would require levees and diversion channels along the upstream side to collect and divert all runoff around them. Diversion channels may also be needed along the upstream side of the campus area to divert flow around construction in this area. Such diversions could be accomplished in short stages, especially for the tunnel excavation,



HYDROLOGIC FEATURES - COLORADO SITE

Figure 7-2



and possibly completed during a no-flow period to further minimize impacts. This would also minimize the changes to drainage areas caused by the diversion and reduce the flows diverted. Direct impacts from changes in the drainage network in the campus and injector areas could be reduced from measurable to negligible levels by using these mitigation measures. These drainage changes would have a negligible impact downstream on Badger Creek.

Permanent redirection of the channel of Sand Creek (tributary to Beaver Creek) may be necessary to accommodate the location of experimental hall K6. Extensive channel redirection and regrading within the Sand Creek floodplain would be required for protection of Hall K6. The impacts of drainage modifications should be minimal because the affected stream is a third-order tributary with only intermittent flow and a low gradient. Increased stream erosion caused by rechannelization would be minimized by maintenance of original channel length and cross-section.

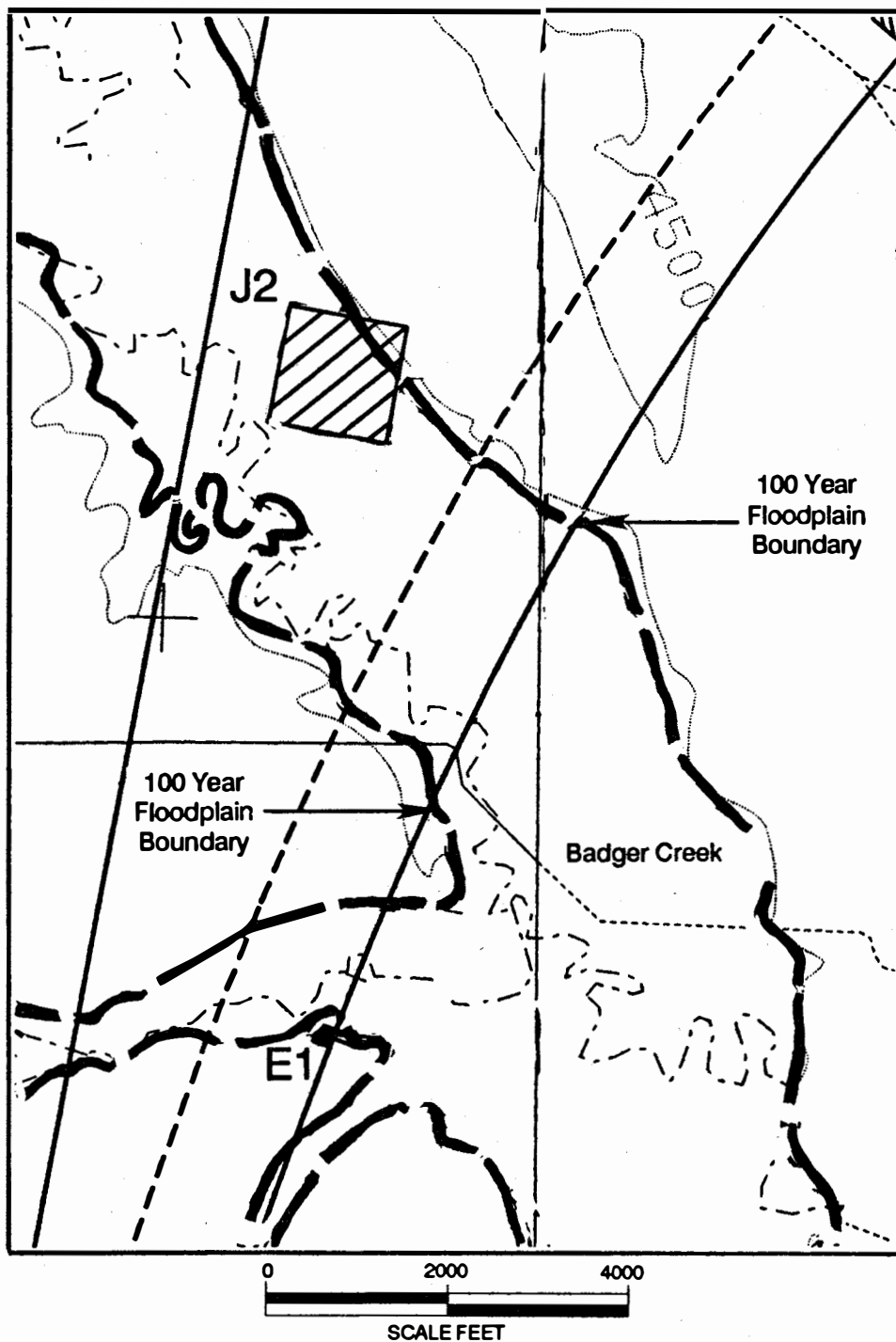
No significant drainage diversion is expected at any of the other surface facilities because they are all relatively small areas (<50 acres), and probably would not require any significant levee or berm construction. The impacts from these minor drainage diversions should be negligible.

### C. Floodplains

None of the stream channels in Adams, Morgan, or Washington counties that are located along the proposed SSC alignment have been mapped for the FEMA Flood Insurance Program. This is an indication that flooding in this area has limited damage potential. It is a rural area with little developed property and intermittently flowing streams. One-hundred-year floodplains were estimated for the local streams (URS Corporation 1988). Results of those analyses were used in this floodplain assessment. During preconstruction, geotechnical and other environmental studies would be performed to verify this assessment as part of final project design. DOE has begun informal consultation with the Omaha District Corps of Engineers concerning their jurisdiction over SSC activities on these streams (Strine 1988).

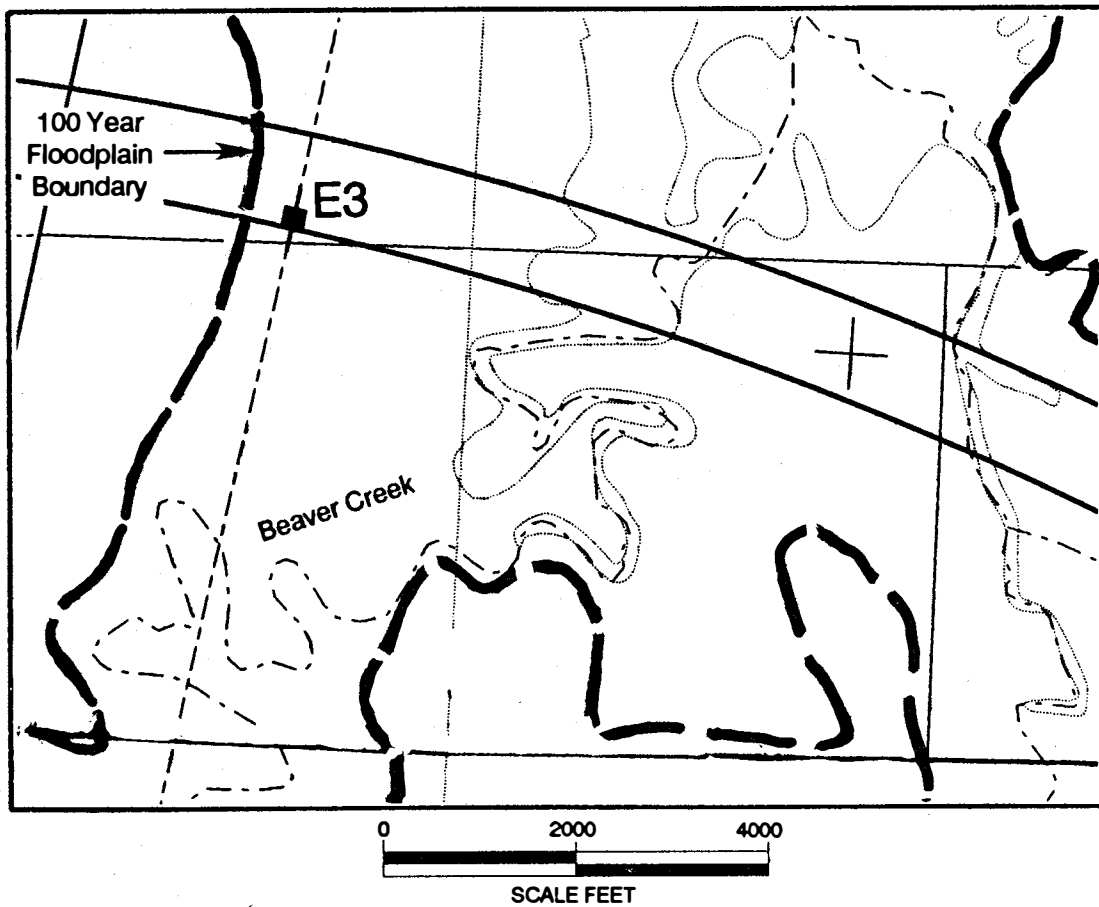
Project facilities that would be located partially or entirely within existing floodplains include: J2 and E1 in Badger Creek (Figure 7-2A); E3 in Beaver Creek at the north ring crossing (Figure 7-2B); F3 in Shears Draw, a tributary of Beaver Creek (Figure 7-2C); K3 in Antelope Creek, a tributary of Beaver Creek (Figure 7-2D); K6 in Sand Creek (Figure 7-2E); E8, a marginal encroachment on Beaver Creek (Figure 7-2F); and F8, an encroachment on Wetzel Creek (Figure 7-2G). The actual placement of surface structures at each of these facilities remains relatively flexible at this time, and would not be determined until a site is selected and site-specific designs prepared. Therefore, potential floodplain encroachment is based on actual land areas and their proximity to floodplains.

Figure 7-2A  
J2/E1 ENCROACHMENT ON BADGER CREEK FLOODPLAIN  
COLORADO SITE



Source: URS Corporation, 1988.

Figure 7-2B  
E3 ENCROACHMENT ON BADGER CREEK FLOODPLAIN  
COLORADO SITE

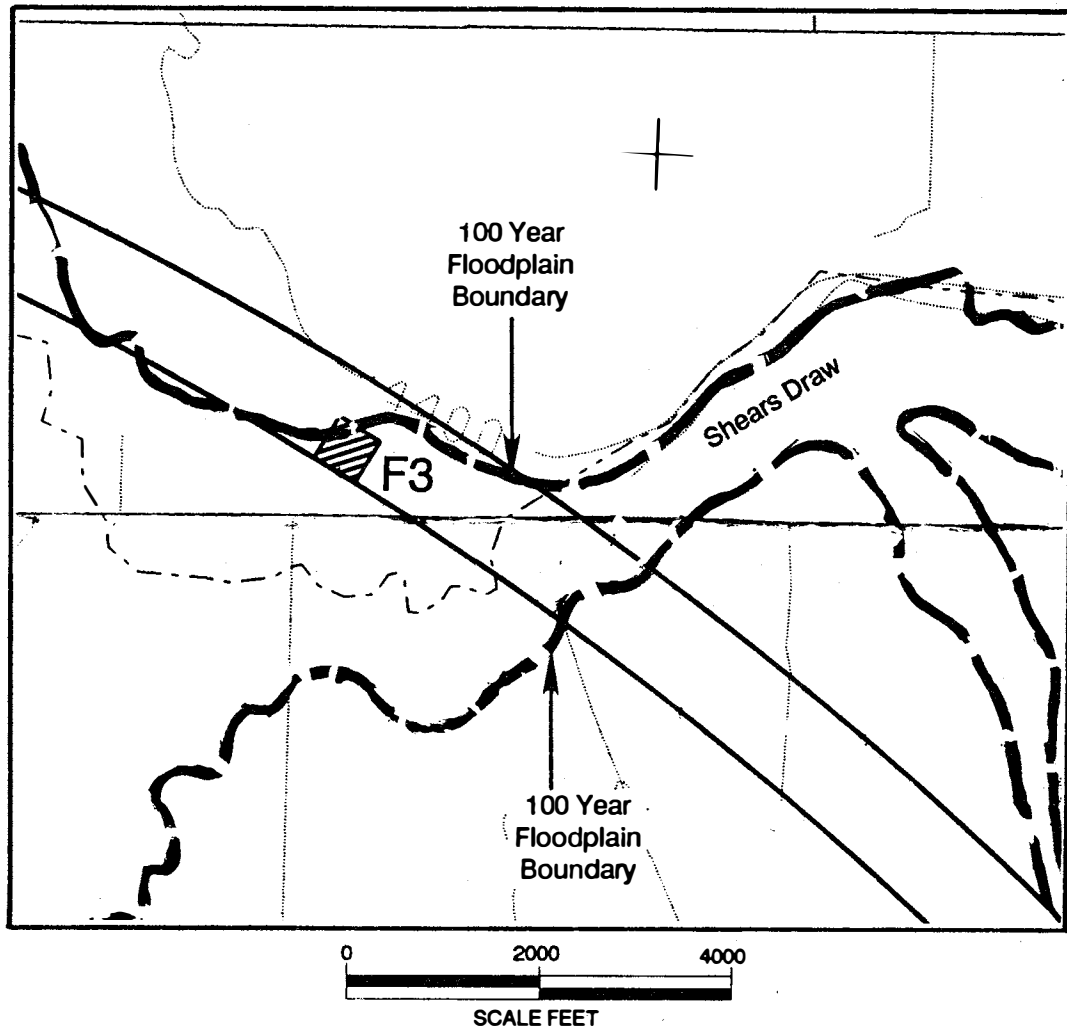


Source: URS Corporation, 1988.

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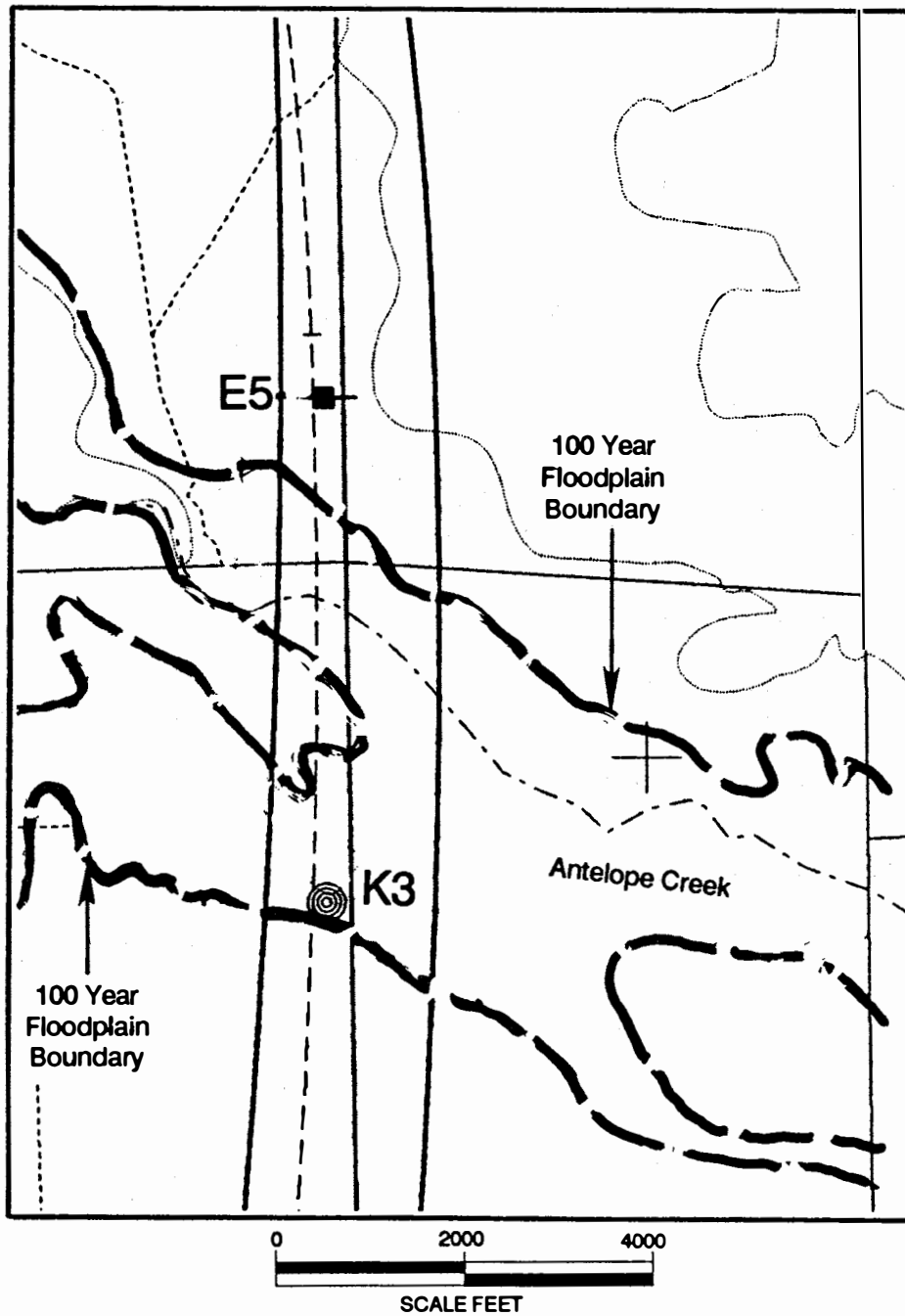
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Figure 7-2C  
F3 ENCROACHMENT ON SHEARS DRAW FLOODPLAIN  
COLORADO SITE



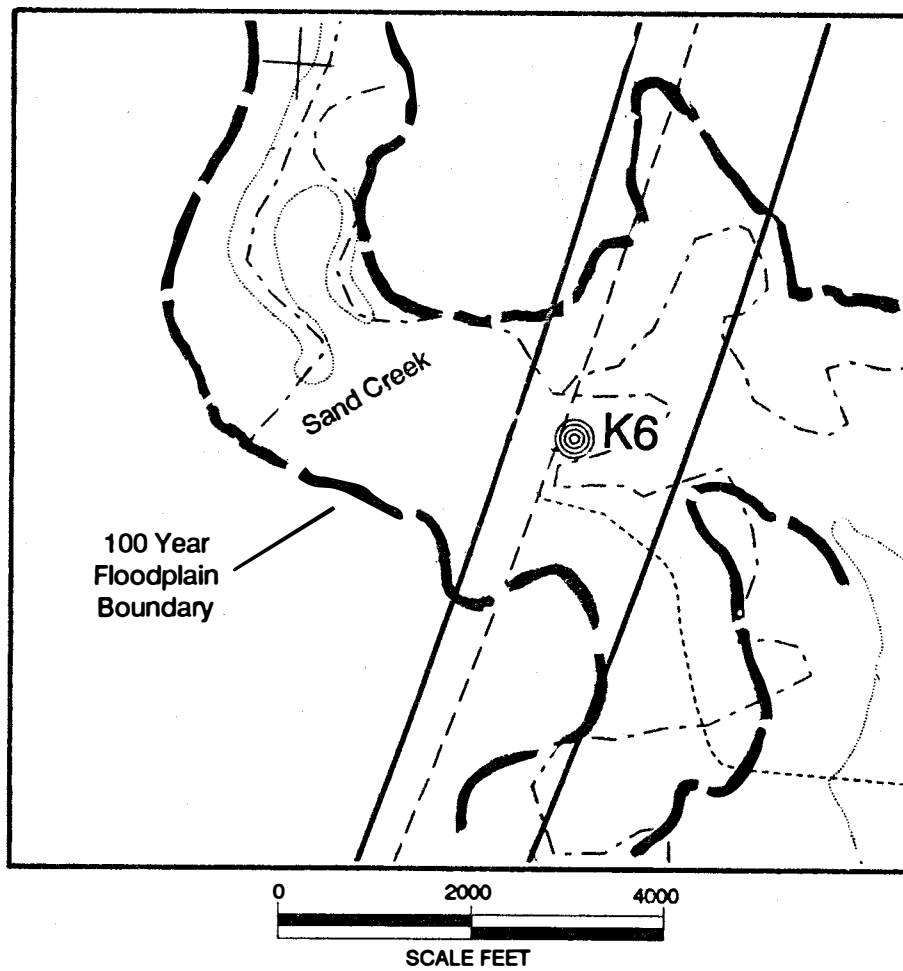
Source: URS Corporation, 1988.

Figure 7-2D  
K3 ENCROACHMENT ON ANTELOPE CREEK FLOODPLAIN  
COLORADO SITE



Source: URS Corporation, 1988.

Figure 7-2E  
K6 ENCROACHMENT ON SAND CREEK FLOODPLAIN  
COLORADO SITE

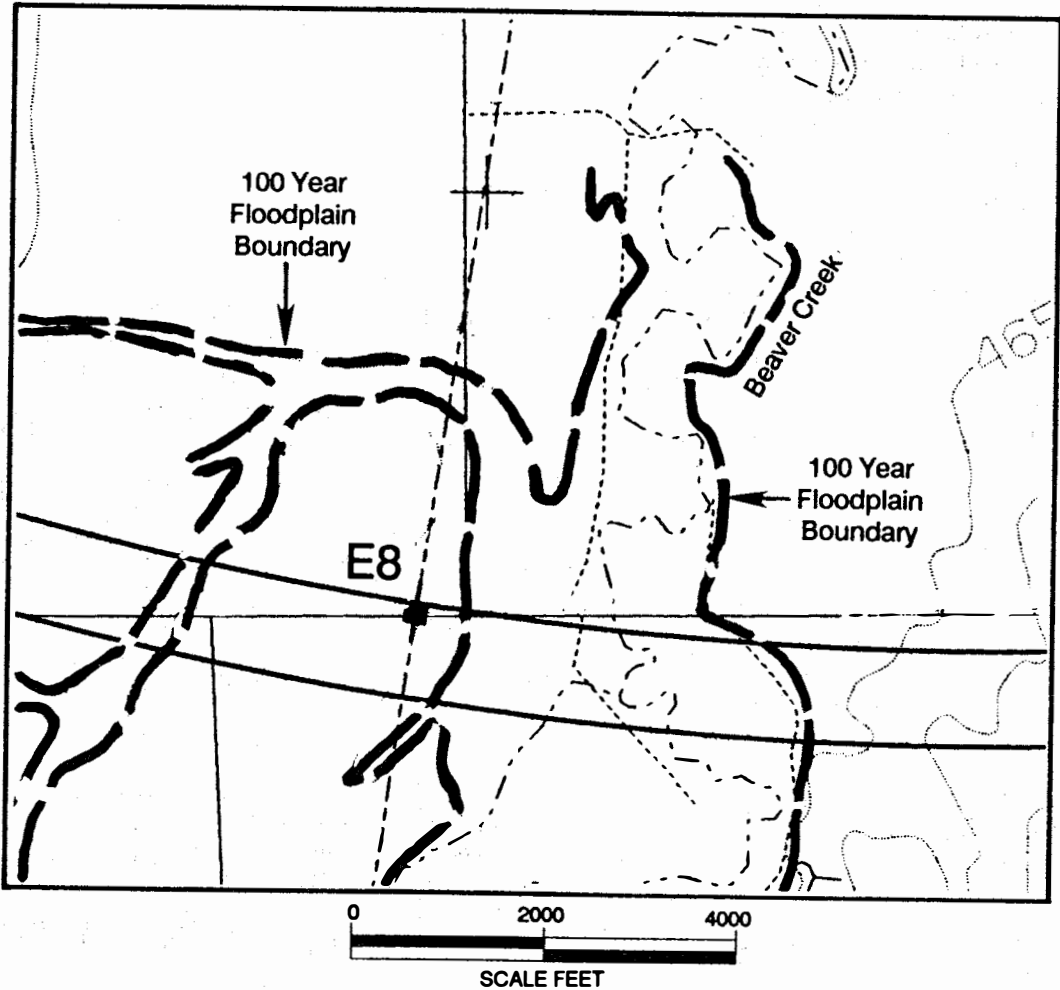


Source: URS Corporation, 1988.

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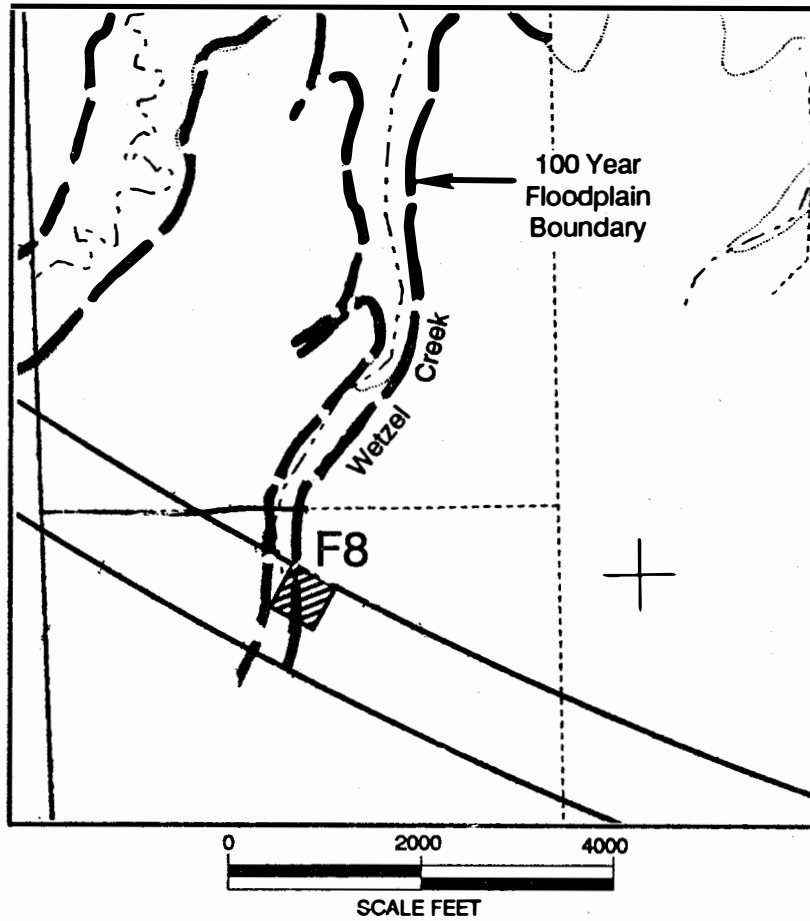
Figure 7-2F  
**E8 ENCROACHMENT ON BEAVER CREEK FLOODPLAIN  
COLORADO SITE**



Source: URS Corporation, 1988.

Figure 7-2G

**F8 ENCROACHMENT ON WETZEL CREEK FLOODPLAIN  
COLORADO SITE**



Source: URS Corporation, 1988.

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Using these floodplain widths it appears that both encroachments on Beaver Creek (E3, E8), the encroachment on Shears Draw (F3), and the E1 facility all represent a minor amount of floodplain loss (<15 percent of the floodplain width). If the design criteria permit flexibility, site-specific design would relocate surface facilities outside of the floodplain which would eliminate the impacts on floodplains and flooding.

External beam access area J2 now includes 1,200 ft of the 3,000-ft-wide floodplain of Badger Creek. Experimental hall area K3 is placed on 2,600 ft of the Antelope Creek floodplain, which is about 3,700 ft wide. Experimental hall area K6 would occupy about 3,700 ft of the 5,000-ft-wide floodplain of Sand Creek. The current land acquisition boundaries for these facilities occupy from 40 to 75 percent of the identified floodplain width. Watersheds upstream from these facilities range in size from 24 mi<sup>2</sup> (Antelope Creek and K3), 114 mi<sup>2</sup> (Badger Creek and J2), to 229 mi<sup>2</sup> (Sand Creek and K6). Service area F8 (Figure 7-2G) will occupy nearly 100 percent of the floodplain of a small tributary to Wetzel Creek. However, less than 10 acres of watershed lies upstream of the site. Construction of these facilities might affect floodplain hydraulics, and could have long-term implications. Mitigation measures such as channel enlargement/improvement, levee construction, and minimizing building locations within the floodplain could help reduce these impacts. These measures could be expensive and may affect the upstream and downstream hydraulics of these channels. Therefore, these measures would be considered as part of final project design. The residual impacts from these three facilities, with mitigation, would probably still exist. However, because the area impacted by any increased flood elevations has few, if any, improved structures, the residual impact should not be significant.

#### D. Surface Erosion

Most of the SSC-related surface disturbances would be within the Badger Creek watershed, including all 200 acres of the campus, about 280 acres of tunnel excavation staging and stockpiling, two experimental halls for 18 acres, two service areas for about 6 acres, and three access areas for 3 to 6 acres. This is a total of about 500 acres (0.8 mi<sup>2</sup>) of disturbed land in a 114-mi<sup>2</sup> watershed, or less than 1 percent of the drainage area. Each disturbance is within a smaller sub-area of this watershed and during construction may cause short-term impacts in these watersheds. As discussed in Section 7.1.3.2.A, each of these disturbances represents about 10 percent of the tributary watershed each is in. Thunderstorm events are relatively frequent (about 50 times per yr) and the low frequency storm events are sizeable (3.2 inches and 3.9 inches respectively, for the 50- and 100-yr, 6-hr storms). Sediment traps and basins could be very effective in reducing the impacts. However, it is expected that there would be an impact for short reaches of channel (<1,000 ft) near the disturbed areas. These impacts would not be measurable further downstream and, thus, would have no impact on the regional scale.

### E. Channel Erosion

Channel erosion results from increasing runoff caused by changed watershed surface characteristics, including removal of existing vegetation and construction of new facilities. As described in Section 7.1.3.2.A, Surface Runoff, increases at the Colorado site are expected to be minimal, partly because of climate and partly because of the small percentage change in any given watershed. The campus area would have the largest percentage of change and the most lasting effect. Disturbed area would be about 200 acres and the permanently changed area about 100 acres (0.2 mi<sup>2</sup>) in a watershed of 8 to 10 mi<sup>2</sup>. This would be about 3 percent disturbed area with less than 2 percent changed permanently. This should have a negligible impact to surface runoff, especially with stormwater management mitigation measures in place. Therefore, increased flows and channel erosion on the Badger Creek tributaries are not expected to result from the SSC.

The other disturbed areas related to the SSC would be distributed or linear and would be even less likely to cause flow increases large enough to impact channels. Given the climate and use of stormwater management measures at these facilities, no channel erosion impacts are expected to result from the SSC.

### F. Water Quality

#### 1. Construction

Surface water flows in Badger Creek and Beaver Creek, which are the major streams crossing the ring, are only intermittent. No information on ambient water quality for either of these creeks is available. However, it is expected that surface waters in the Badger Creek and Beaver Creek watersheds would be high in total dissolved solids and suspended solids. Potential nonpoint sources of pollutants are surface and channel erosion, and pollutant washoff. Potential point sources are leachate from tunnel spoils, industrial wastewater, and treatment plant effluent. The SSC project can also indirectly impact surface waters in a larger region through off-site development induced by the project. This would include more potential erosion, pollutant washoff, and increased flows to wastewater treatment plants.

As discussed in Section 7.1.3.2.D, there would be little erosion, hence little effect on surface water quality. Rainfall is less than 16 inch/yr (U.S. Environmental Science Service Administration 1968), and surface water in Badger and Beaver creeks flows only intermittently. Therefore, the additional sediment load would not be noticeable above existing storm event stream flows. Pollutant washoff should not contribute a significant load to the streams in the area primarily because of the low rainfall amounts in the area. Dewatering of tunnel construction is not expected to be necessary, as discussed in Section 10.2.3.2 of Appendix 10, and therefore should not contribute to water quality impacts.

Four options are presented for the disposal of spoils material from tunneling activities (Section 10.2.3.2, Appendix 10). Three propose to use the materials for such purposes as 1) fill (for a specific floodplain site), 2) aggregate for roadway foundations, and 3) lining new reservoirs under construction. The fourth alternative is to dispose of the material into eight sites situated around the ring area. The first three options could impact water quality during the storage and stockpiling of materials, with erosion of materials or production of leachates.

Erosion of spoils during storage or stockpiling should not be a problem because of the low annual rainfall and short handling times of spoils. Thunderstorms occur on the average of 50 times per year, and the 50- and 100-yr duration, 6-hr storms can dump 3.5 to 3.9 inches during a single event (U.S. Weather Bureau 1966). The potential exists for substantial erosion during such a runoff event and consequently a measurable impact on water quality. However, all of the streams in the SSC area flow only intermittently at best, so impacts on this transient surface water would be negligible. Leachates from spoils containing up to 2 percent gypsum are a concern, because they might be the source for elevated levels of sulfate in local groundwater. However, the spoils would be stockpiled for short time periods and rainfall amounts are so small in the area that leachates should not be a problem. For longer-term disposal or use options, leachate production may be measurable but should not impact surface water directly. Groundwater impacts are discussed later in Section 7.2.3.2 of this appendix.

The eight surface disposal sites would have potential for erosion of spoils and transport of sediment off site. Factors affecting the impact of surface erosion of spoils are the topography at disposal site location, the surface area of the disposal sites, the amount and type of rainfall, and the proximity to perennial stream channels. Two of the eight Colorado disposal sites are located in fairly steep terrain, with the other six on relatively flat topography. One of these two "steep" sites, site 10, is within 4,500 ft of Badger Creek. The total surface area of spoils disposal is 115 acres. Because these areas are relatively small, widely spaced, and generally on flat topography, potential for erosion is small. Their general distance from streams and the lack of perennial streamflow or abundant surface runoff reduces potential for sediment transport off site. Thus, little sediment should move from disposal sites to impact water quality.

Wastewater treatment for the campus area would be provided by installation of a new tertiary treatment facility which would discharge into a tank or pond. If outfall from this treatment plant pond is released into the natural drainage system, an NPDES permit would be required. The tertiary treatment of effluent water would produce effluent with low levels of nutrients and other constituents.

Therefore, a negligible impact to surface water quality would be expected. The same would be true of wastewater discharges from the far cluster, which would have package treatment to the tertiary level. A NPDES permit will be required to discharge treated wastewater to a surface drainage system.

Morgan County would have the largest off-site, indirect impact to water quality from increased wastewater discharge. This would primarily affect the Ft. Morgan and the City of Brush treatment systems. The projected population increase in Morgan County through 1992, the peak construction population, is approximately 3,500 (see Appendix 14, Section 14.1.3.2). This represents an increased wastewater treatment demand of about 350,000 gal/d (assuming 100 gal/d/capita), or about 17 percent of the combined current excess capacity of the Ft. Morgan and the City of Brush wastewater treatment plants (State of Colorado, Department of Natural Resources 1988). Similar comparison of the expected increased demand for treatment in Adams County gives about 16 percent of the existing capacity of the Bennett and Brighton wastewater treatment plants. Since these would be the most heavily affected systems, the increases to off-site wastewater treatment should be well within plant capacities. Because these plants are permitted for their capacities, any increases within those capacities should cause a negligible impact to surface water quality.

## 2. Operations

No specific proposal was made by the State of Colorado for the disposal of industrial wastewater from cooling tower blowdown. If this water is sent to the proposed treatment systems, it would add little additional demand on these systems and not alter the impact assessment. If it is disposed of in evaporation ponds or other closed systems, it would not discharge to surface waters and would have no impacts on their water quality.

## G. Water Use Increase

### 1. Construction

The proposed water supply for the Colorado site construction is groundwater. Expected facility water use during construction has been estimated for the period 1989 to 1995, and is included in Table 7-1. Expected off-site water use increases during construction have been estimated by county and are presented in Table 7-3. Surface water sources would be used only to augment groundwater, by recharge, to those aquifers considered tributary to the South Platte River. The Morgan County Quality Water District (MCQWD) would provide water to the SSC facility from two well fields, the Hay Gulch field and another field in the South Platte tributary system. The latter field would probably provide most of the construction period water supply, which would reach a peak annual demand in 1992 of 88 acre-ft.

The MCQWD has proposed, as one of three augmentation alternatives, to use surface water transferred from the Colorado River basin to the Big Thompson River and then diverted to an existing distributary system (the Colorado-Big Thompson or CBT project) as the source of augmentation. This augmentation would not require any additional interbasin water transfers from the Colorado River and, thus, should not impact the Colorado River. Instead the MCQWD plans to purchase water rights from current CBT water users in the South Platte River basin who are willing

Table 7-3

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
 DURING SSC CONSTRUCTION AND OPERATIONS IN COLORADO<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)							Water Use During Operations (acre-ft/yr)
	1989	1990	1991	1992	1993	1994	1995	
Morgan County	110	415	740	775	670	725	625	475 - 610
Counties West of Site <sup>2</sup>	165	580	1,035	1,045	875	920	765	590 - 765
Counties East of Site <sup>3</sup>	<u>5</u>	<u>25</u>	<u>50</u>	<u>50</u>	<u>40</u>	<u>45</u>	<u>40</u>	<u>30 - 35</u>
TOTAL	280	1,020	1,825	1,870	1,585	1,690	1,430	1,095 - 1,410

1. Estimated domestic water use is based on population projections multiplied by a factor of 200 gal/d/capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Colorado. The estimates do not include water delivered for industrial and commercial use.
2. Includes estimates for Adams, Arapahoe, Boulder, Denver, Douglas, Elbert, Jefferson, and Weld counties.
3. Includes estimates for Kit Carson, Lincoln, Logan, Washington, and Weld counties.

to sell their water allocation rights. This could be a measurable impact to those current users who sell their water rights, but it would be their decision and they would be compensated. Otherwise, there would be no impact to surface water use. By using the augmentation process, flow of South Platte River water downstream of the SSC would be maintained at current levels. However, depending on location of the point of diversion of purchased water rights, there may be small changes in flow over short reaches of the river. These would not have any hydrologic impact. Actual purchase of CBT water for augmentation would range from 88 to 170 acre-ft during the peak demand year 1992, because of possible transmission losses. This purchase represents on the average less than 0.1 percent of the total CBT water transferred per year.

Off-site water use probably would be supplied by wells not requiring surface water augmentation. However, if any of the off-site water were to be taken from wells requiring augmentation, it would require an additional use of 775 to 1,550 acre-ft of water from the CBT. This still represents less than 1 percent of the current CBT allocations, which are about 245,000 acre-ft/yr. Any required augmentation would be obtained through purchase of water rights.

## 2. Operations

The proposed water supply source for SSC operations would be groundwater. Groundwater augmentation by CBT water would be used during SSC operations, primarily for the industrial water supply. This would be an annual requirement of about 1,300 acre-ft, or 1,300 to 2,600 acre-ft of CBT water purchased per year. Add an estimated 475 to 610 acre-ft of off-site use in Morgan County, or 475 to 1,220 acre-ft of CBT water, and the potential total demand is 1,775 to 3,820 acre-ft. Currently, this represents only from 0.7 to 1.5 percent of the average CBT water allocation.

### 7.1.3.3 Illinois

#### A. Surface Runoff

The Illinois site is located about 40 mi west of Chicago. The eastern portion of the site contains numerous small communities that are experiencing rapid urban development. This area also includes the Fermilab property, which would provide the project injector and booster facilities along with much of the required campus complex. The western portion of the project is situated in a predominantly agricultural area. The site and regional areas associated with hydrologic impacts are shown in Figure 7-3.

Because most of the surface facilities necessary for the SSC campus already exist at Fermilab in Illinois, the SSC facility would cause a smaller impact to surface water than would occur if new facilities were developed. Total anticipated land disturbance at the Illinois site is about 500 acres. Construction in the campus area should disturb less than 190 acres, including land clearing, development of site access, and other associated disturbances such as spoils piles. The injector/booster connector tunnel construction would disturb approximately 5 acres for excavation, stockpiling, site access, and other associated disturbances. The latter disturbance would be short-term, lasting only until construction is completed, the excavation is filled, and the surface returned to preconstruction conditions. When combined, the total is 195 acres (0.3 mi<sup>2</sup>) of disturbed area in the Kress Creek basin, a 3.6-mi<sup>2</sup> watershed, tributary to the DuPage River. Thus, about 8 percent of the watershed would be disturbed and with the plentiful rainfall in the region, about 34 inch/yr (U.S. Environmental Science Services Administration 1968), may cause a measurable impact. However, with the use of detention basins, surface storage, and other stormwater management measures, this impact could be mitigated and reduced to a negligible level.

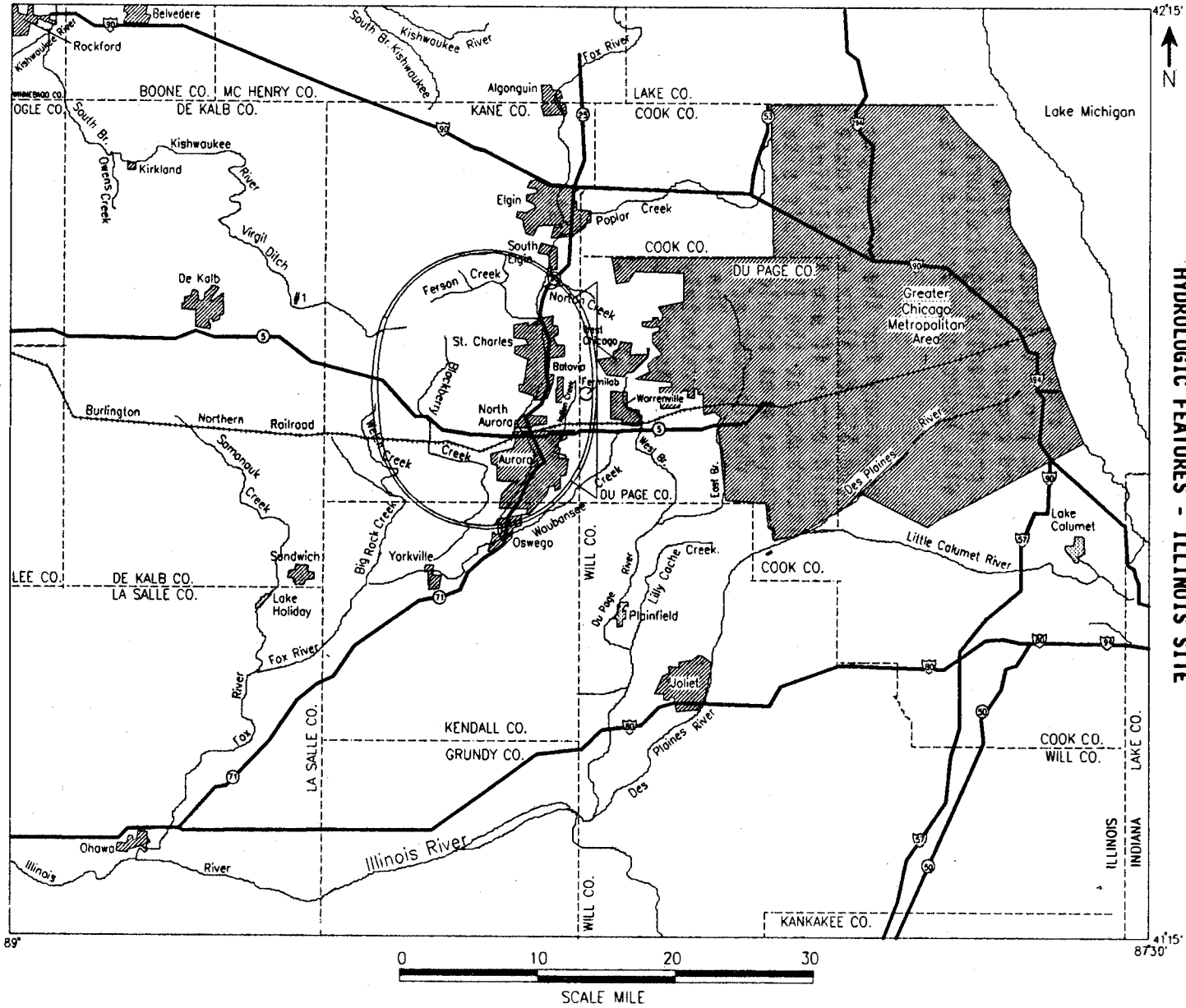
Other parts of the SSC facility that would cause surface disturbance are the service areas (F1 through F9 at about 4 acres each), and the intermediate access areas (E1 through E10, at 1 to 2 acres each). The disturbed area estimates for these facilities include actual land cleared for the building, staging site access, and other activities such as spoils piles. Since no firm construction plans exist for any site, these estimates of disturbed areas are general and conservative. All of the access and service areas are distributed around the ring and, therefore, represent small areas of disturbance within different watersheds. The impact of these disturbances to surface runoff would be negligible.

#### B. Drainage Network

Only four facilities for the proposed Illinois location have potential for causing stream channel relocation. Welch Creek would have two of these facilities located near the stream channel; F5 would be within about 200 ft of the floodplain and K4 would lie immediately adjacent to the floodplain. These facilities create a small potential for channel relocation, but almost no change in drainage area. Similarly, two

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HYDROLOGIC FEATURES - ILLINOIS SITE

Figure 7-3



facilities in the Kress Creek watershed would be near or in the stream channel: J3 would be within 1,000 ft of the floodplain and J6 would encroach the entire floodplain. If stream diversions are necessary at either of these locations it would not involve any changes to the drainage area of Kress Creek or its tributaries. Without any change to drainage areas, the impacts to the drainage network from any of the four facilities would, therefore, be negligible. Impacts to the floodplains are discussed in the following section.

### C. Floodplains

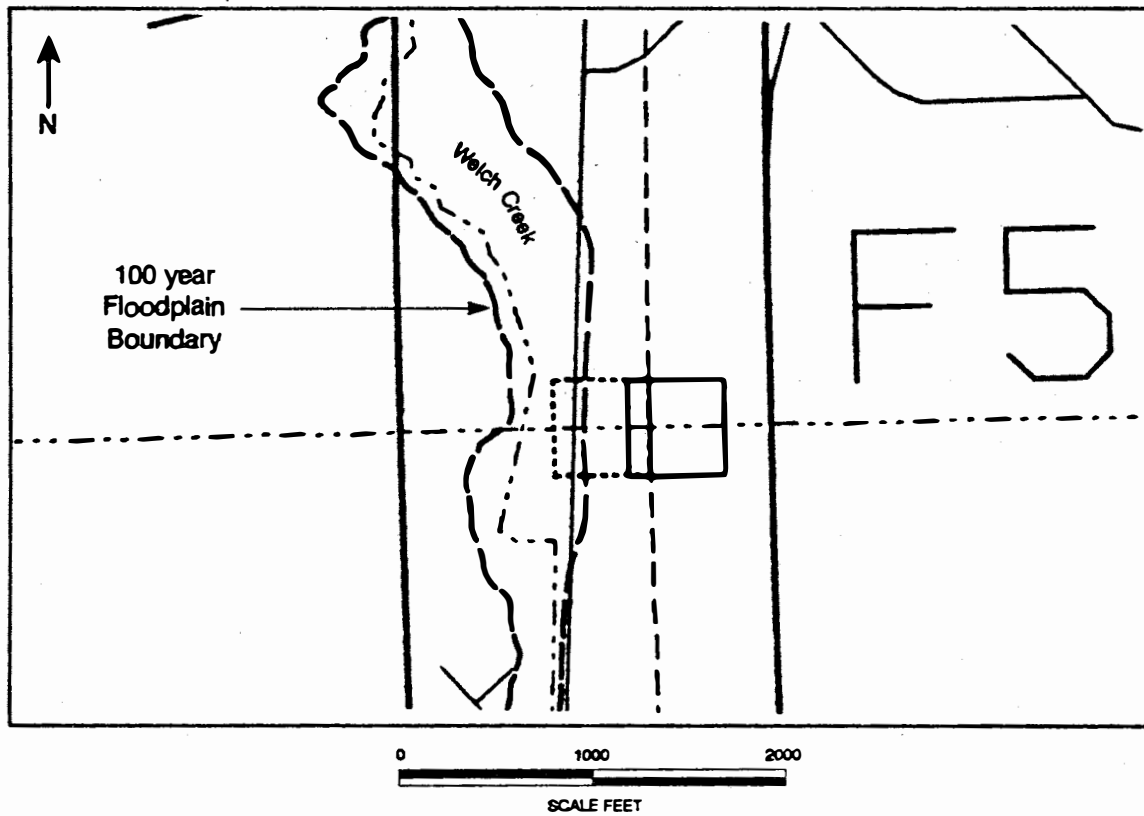
The entire SSC region in Illinois has been included in the national flood insurance program, and FEMA Flood Insurance Rate Maps have been prepared (Federal Emergency Management Agency 1981a, 1981b, 1981c, 1981d, 1981e, 1981f, 1982a, 1982b, 1982c, 1982d, 1982e, 1982f, 1985a, 1985b, 1986a, 1986b, 1987). This includes all of the unincorporated areas of DuPage, Kane, and Kendall counties and several incorporated communities. Therefore, in preparing this floodplain assessment, the FEMA maps were used. DOE has initiated informal consultation with the Chicago District Corps of Engineers concerning floodplains. If the Illinois site were selected, during preconstruction analyses, geotechnical and other environmental studies would be performed to verify the following assessment as part of final project design.

The four facilities identified in Section B., Drainage Networks, all have some potential for floodplain encroachment. At present, these facilities are described by a conceptual design that does not contain specific details on where the buildings and other surface structures would be placed within the area. Therefore, a discussion of floodplain encroachment can only address very general concerns. Surface structures would occupy only a part of the area needed for each facility, and the location of these structures within the area remains flexible in most cases. The four facilities with potential floodplain encroachment would impact only Welch Creek in the far cluster and Kress Creek in the near cluster; the F5 and K4 facilities are located along the former, and the J3 and J6 facilities next to the latter.

Service area F5 is currently located within about 200 ft of the Welch Creek floodplain, which is about 300 to 600 ft wide (Figure 7-4). This facility area lies close enough to the floodplain that further consideration is needed. However, adjustment in building location could likely mitigate any potential impacts. Impacts to the Welch Creek floodplain from the F5 facility should, therefore, be negligible.

Experimental hall K4 lies immediately adjacent to the Welch Creek floodplain, which is about 750 to 1,000 ft wide (Figure 7-5). While not an encroachment this is close enough to deserve consideration during final design. This particular facility should be easily mitigated by layout of the facility during final project design. As a result the impact from floodplain encroachment on Welch Creek caused by facility K4 is expected to be negligible.

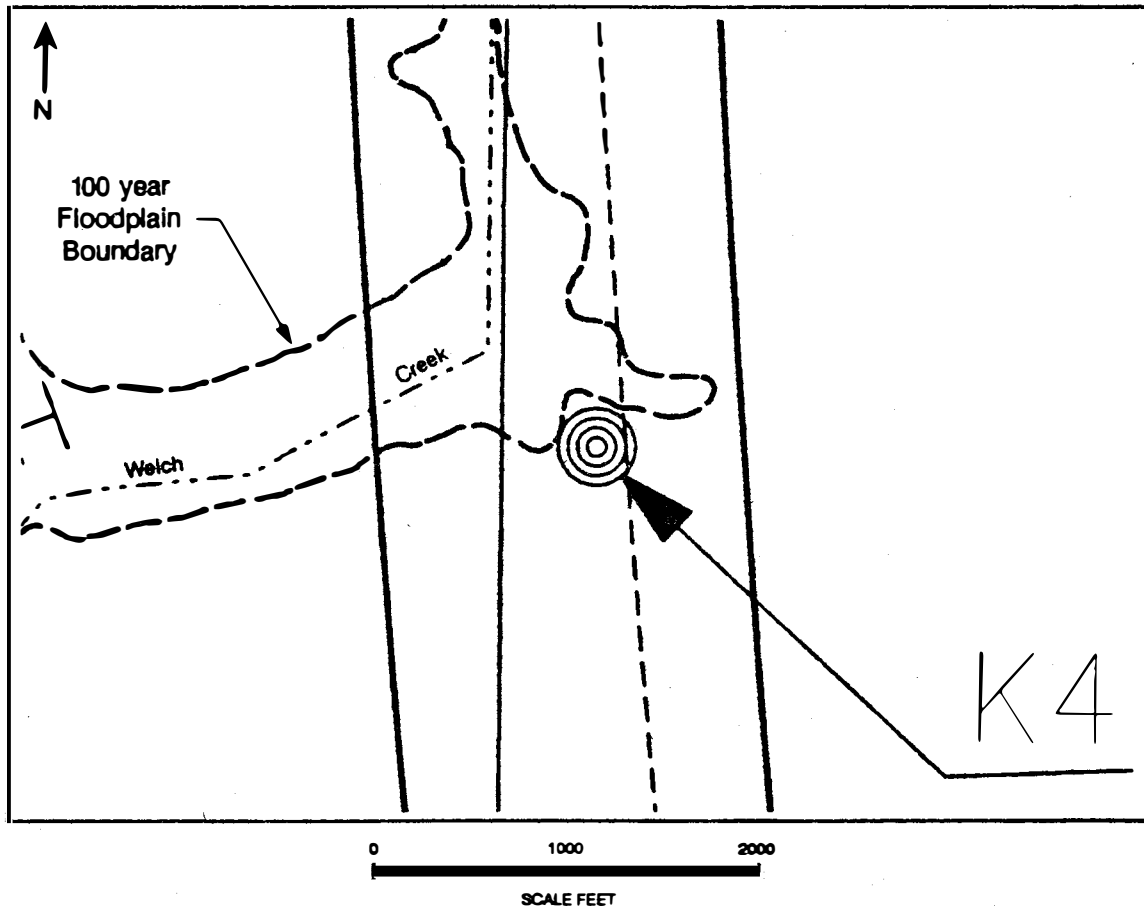
Figure 7-4  
F5 ENCROACHMENT ON WELCH CREEK FLOODPLAIN  
ILLINOIS SITE



Source: Federal Emergency Management Agency, 1982b.

Figure 7-5

**K4 ENCROACHMENT ON WELCH CREEK FLOODPLAIN  
ILLINOIS SITE**



Source: Federal Emergency Management Agency, 1982b.

External beam access area J3 is within 1,000 ft of the floodplain of Kress Creek (Figure 7-6). This is close enough that further consideration is warranted. Very little has been determined about the layout of the J areas, but 40 acres would provide some flexibility in arrangement of the surface structures. Thus, design mitigation allows avoiding any impact to the floodplain of Kress Creek from J3.

Facility J6, as currently located, covers the entire width of the floodplain of Kress Creek with its northeast corner (Figure 7-7). This is a measurable impact, with some potential for mitigation through design layout or channel diversion. One potential mitigation would be relocating, at design stage, surface structures in flood fringe rather than in floodway (structures located in flood fringe would not significantly raise upstream flood elevation). Other potential mitigations include elevating the structures, diverting the stream, and improving the channel to reduce flood stage. More detailed evaluation of this problem would be made during final site design if the Illinois site is selected.

#### D. Surface Erosion

Construction activities cause surface disturbances by clearing vegetation, grading, excavating, and other construction equipment movement. This disturbance occurs primarily at the site, but would also induce a regional disturbance by access road construction, railroad line extension, new water lines, new sewers, a new wastewater treatment plant, and new gas lines. A discussion of these features as proposed for the Illinois facility is given in Appendix 1, Section 1.2.3.

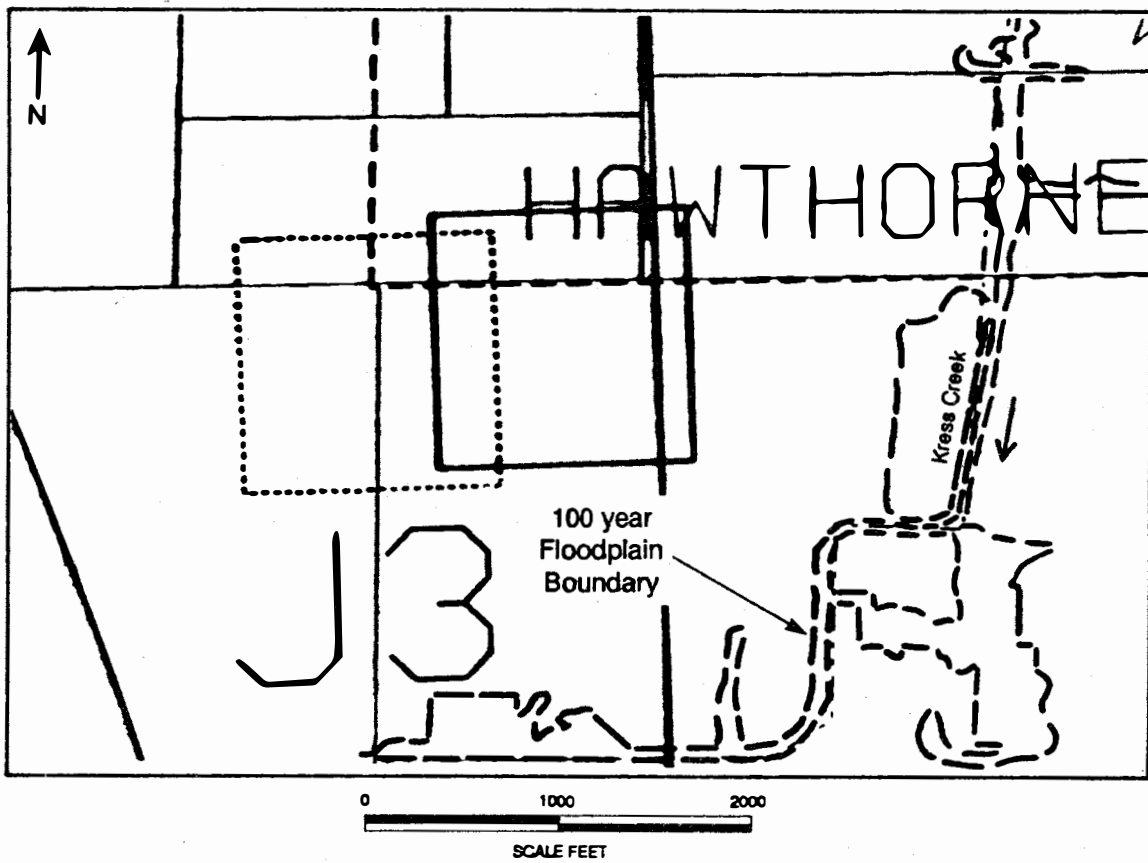
Actual construction activity for the Illinois site would be relatively limited. Two types of disturbance would be involved, surface development and open excavation. The site would have about 190 acres of campus disturbed, because of the proposed use of existing Fermilab facilities. Ten access areas (E1 through E10) would disturb 1 to 2 acres each, spread around the ring. Nine service areas outside the campus (F1 through F9) would each disturb about 4 acres, also evenly spread around the ring.

Only one area of open excavation would be necessary, for a connector tunnel linking the main SSC tunnel with the Fermilab tunnel, to be used as the injector/booster for the facility. The actual excavation area would only be 5 acres.

The most disturbed watershed would be Kress Creek, which contains the campus area and the injector/booster excavation. This represents a disturbed area of approximately 195 acres (0.3 mi<sup>2</sup>) in a 12.6-mi<sup>2</sup> watershed, or about 2 percent of the watershed. Other disturbed areas are quite evenly distributed around the ring and among other watersheds, with no disturbance representing more than 2 percent of the watershed area in which it is located and most being less than 1 percent of the watershed. None of this disturbance constitutes more than a negligible impact to the streams from increased surface erosion. Short reaches no more than 100 to 200 ft long, adjacent to construction or excavation areas, may

Figure 7-6

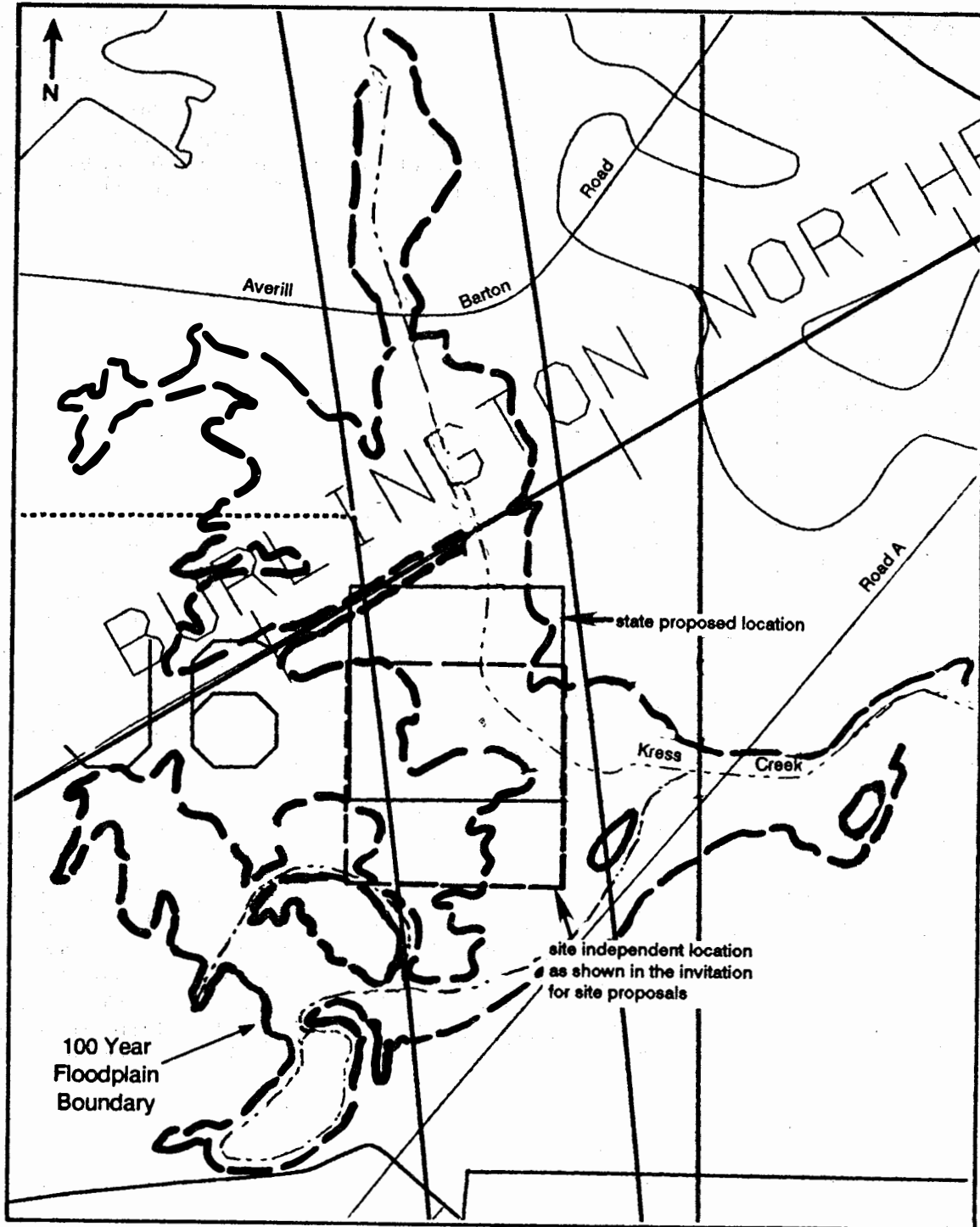
J3 ENCROACHMENT ON KRESS CREEK FLOODPLAIN  
ILLINOIS SITE



Source: Federal Emergency Management Agency, 1987.

Figure 7-7

J6 ENCROACHMENT ON KRESS CREEK FLOODPLAIN  
ILLINOIS SITE



Source: Federal Emergency Management Agency, 1982f.

experience short-term, minor accumulations of sediment. However, this sedimentation can be reduced to negligible levels with the use of sediment traps and basins.

There is a potential for construction-related impacts to field tile-drains in the southwest quadrant of the ring at the Illinois site. If drain tiles become blocked there is a potential for fields to flood, damaging crops. Possible approaches to avoid or mitigate impacts to tile-drain systems include: shifting construction locations away from identified drains, redirecting drains around construction sites, and reinforcing drain tiles that pass beneath new road or rail lines.

Regionally, improving access to the site for transportation and utilities would add a minor amount of additional surface disturbance. One tollway interchange, one major intersection, 4 mi of improved highway, 16 mi of improved roads, 3 mi of new roads, and 0.8 mi of railroad siding would also be disturbed around the proposed ring. New water, sewer, and gas lines would also cause minor, well-distributed disturbances around the facility.

#### E. Channel Erosion

Channel erosion impacts result from increases in surface water runoff and greater streamflow. The higher channel-forming discharges would increase and apply greater erosive power to the channel. In Illinois, land surface disturbance and change caused by the SSC facility construction would be small, and as discussed earlier under Surface Runoff (Section 7.1.3.3.A), the expected increase in runoff would be negligible. Therefore, streamflow should remain close to existing conditions near the facility, even in the campus area. This would mean a very small increase in erosive power and a negligible impact on channel erosion, both near the site and regionally.

#### F. Water Quality

##### 1. Construction

Impacts to surface water quality can be caused by SSC construction both directly and indirectly. Directly affecting water quality are surface erosion, channel erosion, pollutant washoff, dewatering, increased wastewater treatment plant effluent, and leachate runoff from tunnel spoils piles. The SSC facility can indirectly affect surface water quality through erosion and pollutant washoff from areas developed because of immigration induced by the project. Additional wastewater treatment associated with this secondary development would also be an indirect impact.

The Kress Creek watershed contains the largest concentration of surface disturbance. However, as described previously in Section D., Surface Erosion, and Section E., Channel Erosion, the erosion should be negligible. Therefore, little additional sediment would be contributed to the stream channels, and the natural water quality should be affected

very little by increased sediment loads. Short channel reaches (<1,000 ft) near construction activity may experience some minor, temporary water quality impacts from sedimentation. Such measurable impacts can be effectively mitigated with sedimentation basins and traps, reducing the residual impact to negligible levels.

Pollutant washoff from SSC construction areas or developed facilities should be relatively small. The campus area is already developed, so little additional construction would be necessary. Activity at the campus would not increase appreciably either, so auto emissions and other pollutant sources contributing to washoff would not increase by much. The impact to surface water quality resulting from any pollutant washoff is, therefore, expected to be negligible.

Dewatering or removal of groundwater inflow from the tunnel at the Illinois site would require sedimentation ponds to control this water, as described in Appendix 10 (Section 10.2.3.3.B). Plans for treating wastewater from tunnel dewatering should be further evaluated during final site design. With adequate treatment, impacts to surface water quality from tunnel dewatering would be negligible.

Increases to wastewater discharge would occur at the Batavia treatment plant discharging into the Fox River, the Naperville Springbrook treatment plant discharging to the DuPage River, and a treatment plant that would be built near the far cluster discharging to Welch Creek, a tributary to the Fox River. Amounts of increase of treated effluent from these plants are not known at this time. However, any increases within their current operating capacity would be covered under their effluent discharge quality limitations. If expansion of capacity is necessary because of these increased loads, water quality concerns would be addressed through a change in current NPDES permits or application for a new one. The permit process would ensure that additional wastewater discharged to these streams would be acceptable for the water quality classification of the stream. Therefore, impacts to surface water quality from additional wastewater discharges should be negligible.

No potential leachates that could be produced by the tunnel spoils have been identified. The proposed disposal of tunnel spoils in active quarries for blending with the quarry product also minimizes potential impacts to surface water quality.

Indirect regional impacts to surface water quality would result from in-migration induced by the SSC project. Expected additional wastewater treatment loads can be estimated by comparing population increase projections to existing sewage treatment plant capacities. As described in Appendix 5, Section 5.3.8.1, DuPage and Kane counties each have six existing wastewater treatment plants with an aggregate excess capacity of 12.2 and 15.4 million gal/d, respectively. The expected peak population growth in each county through 1992 is about 2,000 people in DuPage and about 3,600 in Kane (Appendix 14, Section 14.1.3.3). Using an average of 100 gal/d of additional wastewater from each individual,



expected SSC increases to off-site treatment would be 1.6 percent and 2.3 percent of the existing excess capacity in DuPage and Kane counties, respectively (Illinois Environmental Protection Agency, Division of Water Pollution Control 1988). Thus, expected increases are well within the existing capacities, assuming an even distribution among the plants. Because these treatment plants are permitted for discharge loads within their capacities, these increases should cause a negligible impact to surface water quality.

## 2. Operations

The only area of concern for surface water quality impacts associated with SSC operations would be discharge of wastewater and/or cooling tower blowdown into surface waters. Wastewater and cooling tower blowdown from the campus area, injector complex, experimental halls K1 and K2, and service area F5 would be collected and sent to the Batavia treatment plant. This would be an additional loading of 150,000 to 225,000 gal/d on the Batavia plant. Combined with an expected 150,000 gal/d of sewage, the total additional load from operations would be 300,000 to 375,000 gal/d. Existing excess capacity available at the Batavia plant is 920,000 gal/d (Illinois Environmental Protection Agency, Division of Water Pollution Control 1988). Thus, additional wastewater treatment would require about one-third of the existing excess capacity. Because this is within the existing plant capacity, which has an NPDES permit, this should only cause a negligible impact to water quality. The sewage from the far cluster area and other remote locations will be treated at a new Kaneville wastewater treatment plant. Cooling tower blowdown from remote areas will be treated by a vacuum compression brine concentrator unit or side-stream softener.

Expected off-site population increases associated with SSC operations would be approximately 1,800 people in DuPage County and 3,400 in Kane County. This represents an increase in wastewater production of 180,000 gal/d and 340,000 gal/d in each of these counties, respectively. This would still be a very small percentage of existing plant capacities for either of these counties (Illinois Environmental Protection Agency, Division of Water Pollution Control 1988).

## G. Surface Water Use

### 1. Construction

The proposed water supply for the Illinois site construction is groundwater; no surface water would be used. General use during construction has been estimated for the period 1989 to 1995 for the facility, and is included in Table 7-1. Off-site use during construction has been estimated by county and is presented in Table 7-4. The only current use of surface water for water supply is Fermilab itself. No use of this water is proposed for construction purposes; thus there would be no impact of the project on surface water sources.

Table 7-4

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
 DURING SSC CONSTRUCTION AND OPERATIONS IN ILLINOIS<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)						Water Use During Operations (acre-ft/yr)	
	1989	1990	1991	1992	1993	1994		1995
DuPage County	25	85	155	165	150	160	140	115 - 150
Kane County	40	150	275	300	270	295	265	220 - 285
Cook County	45	130	250	260	220	215	160	125 - 175
Other Nearby Counties <sup>2</sup>	<u>15</u>	<u>50</u>	<u>95</u>	<u>100</u>	<u>90</u>	<u>90</u>	<u>75</u>	<u>60 - 80</u>
TOTAL	125	415	775	825	730	760	640	520 - 690

1. Estimated domestic water use is based on population projections multiplied by a factor of 75 gallons/d/capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Illinois. The estimates do not include water delivered for industrial and commercial use.

2. Includes estimates for Kendall, Boone, DeKalb, Lake, McHenry, and Will counties.

**2. Operations**

The proposed SSC operations water supply would be groundwater. Therefore, water used at the site during operations would be derived entirely from groundwater, with the exception of the current Fermilab industrial water system, which would not be modified by SSC operations. Therefore, no impacts to surface water sources are expected.

A portion of the Fox River water currently being used by Fermilab could eventually supply the SSC. This would reduce the incremental on-site water need for SSC operations at the proposed Illinois site. However, as Fermilab activities are planned to continue, the amount of any transfer of supply would likely be small.

#### 7.1.3.4 Michigan

##### A. Surface Runoff

Hydrologic conditions of the local basins include low relief and poor drainage. Because the climate is wet with potential for intense rainfall, runoff increases could be important. However, the inefficient natural drainage systems would tend to dampen changes caused by surface disturbances. The site and regional areas associated with hydrologic impacts are shown in Figure 7-8.

Total disturbed area at the Michigan site is anticipated to be about 1,080 acres. Disturbed surfaces would include about 480 acres in the campus and injector areas, and about 80 acres for other primary facilities distributed elsewhere around the ring. The campus and injector area figure assumes that about 200 acres of the campus would be disturbed, and about 280 acres would be disturbed for the injector/booster complex. The latter disturbance would include about 120 acres of open excavation, and the rest would be used for stockpiling, staging, access, and other associated surface disturbances. This disturbance falls within the Thornapple Creek watershed, which is a tributary to Orchard Creek. It represents about 7.5 percent of the Thornapple Creek drainage area, and about 1 percent of the Orchard Creek watershed area. There is a moderate amount of rainfall in the area (about 31 inch/yr) distributed throughout the year (U.S. Environmental Sciences Services Administration 1988). Potential exists for large rainfalls (3.5 inches and 3.7 inches respectively for the 50- and 100-yr, 6-hr storms) with thunderstorms occurring about 46 times per year (U.S. Weather Bureau 1961). Therefore, the disturbances may cause a measurable impact to Thornapple Creek discharges, but would have only a negligible impact on Orchard Creek. With the use of detention basins, potential impacts to Thornapple Creek could be reduced to negligible levels. Surface disturbance elsewhere around the ring would be much smaller in any given watershed, no more than about 5 acres for a single facility. These other disturbances, therefore, would be a very small percentage of the land area in basins where they fall, and would have negligible runoff increase impacts.

On a regional scale, disturbances caused directly by SSC development would be about 480 acres in the campus and injector area and 1,080 acres for the entire site. The watersheds under consideration on the regional scale are much larger. Thus, the percentage of disturbed area would be smaller, and it is distributed among many watersheds.

##### B. Drainage Network

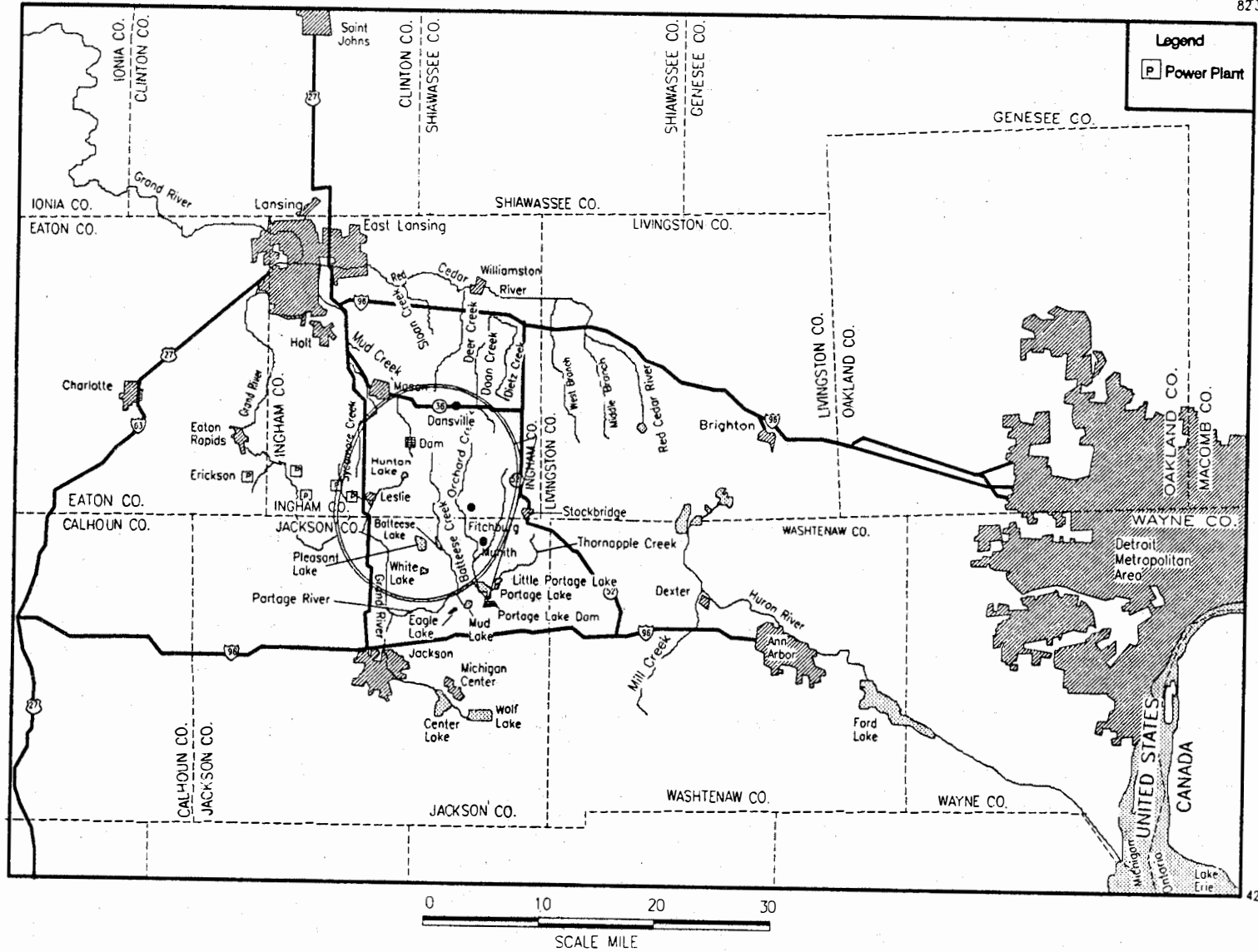
The only drainage network modifications anticipated for the SSC project in Michigan would be in the injector and booster complex cut-and-fill construction. Because this would only be a temporary channel diversion of less than 50 ft on a very small stream in two or three locations in a staged sequence, the impact from this drainage modification would be negligible. This would be on Thornapple Creek and tributaries, and

85°

82°30' 43" N

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Figure 7-8

would involve essentially no changes in drainage area. None of the other SSC facilities would require stream diversions or drainage network modification. Therefore, site vicinity impacts outside the campus and injector complex would be negligible. Regional impacts from drainage pattern modification, including both primary site construction and secondary development effects, would also be negligible. This conclusion also accounts for new transportation access construction and its potential for causing drainage network impacts.

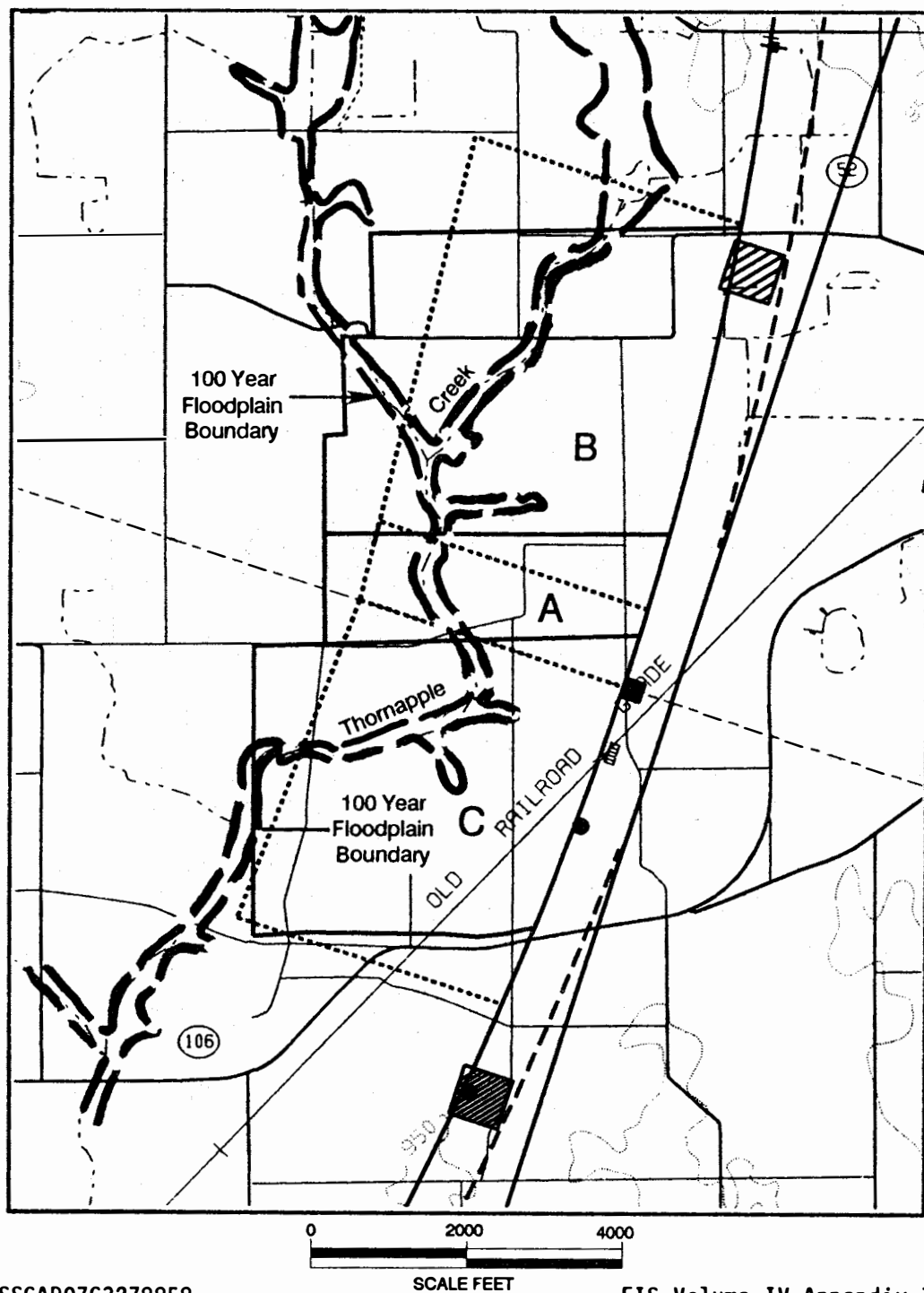
### C. Floodplains

Very little of this proposed site has been mapped for the national flood insurance program. FEMA Flood Insurance Rate Maps have been prepared only for a small portion of the SSC area near the Grand River in Blackman Township where it crosses the ring alignment. Flood Hazard Boundary Maps have also been prepared for other minor parts of Jackson and Ingham counties, except the unincorporated areas of the counties as a whole. This indicates a relatively low potential for flood damage to improved properties in the site vicinity.

In order to prepare this floodplain assessment, U.S.G.S. Flood Prone Area Maps of the proposed SSC location were used to determine whether any of the facilities may be in the 100-yr floodplain (Menerey 1988). Temporary floodplain encroachment because of construction activities would likely occur on Thornapple Creek where it passes through the injector and booster areas (Figure 7-8A), and to a lesser extent in the campus area. The cut-and-fill construction of the injector and booster tunnels would cross Thornapple Creek twice and come very close to the channel in a third location. All three locations probably would encroach on the floodplain temporarily, especially where the tunnel alignment crosses the creek. Although the creek is a small one (less than a 10-mi<sup>2</sup> drainage area), this impact could be measurable. Three service areas, F1 (Figure 7-8B), F2 (Figure 7-8C), and F6 (Figure 7-8D) all may, depending upon final design, encroach on floodplains. F1 and F2 could encroach upon the Portage River floodplain, which has an upstream watershed of 80 mi<sup>2</sup>. Even without mitigation the encroachment impacts are likely to be minor. The F6 area could have marginal encroachment upon the Sycamore Creek floodplain, which has an upstream watershed of 18 mi<sup>2</sup>; however the impacts are expected to be minor. Mitigation by relocating these facilities to minimize the floodplain encroachment is the best initial strategy. Protection from or confinement of the additional flood elevation by levees or berms is another reasonable alternative. Either alternative could effectively reduce the impact. No other potential floodplain encroachments exist at the other SSC surface facilities and, therefore, no additional floodplain encroachment impacts would be expected.

Figure 7-8A

CAMPUS AREA ENCROACHMENT ON THORNAPPLE CREEK FLOODPLAIN  
MICHIGAN SITE

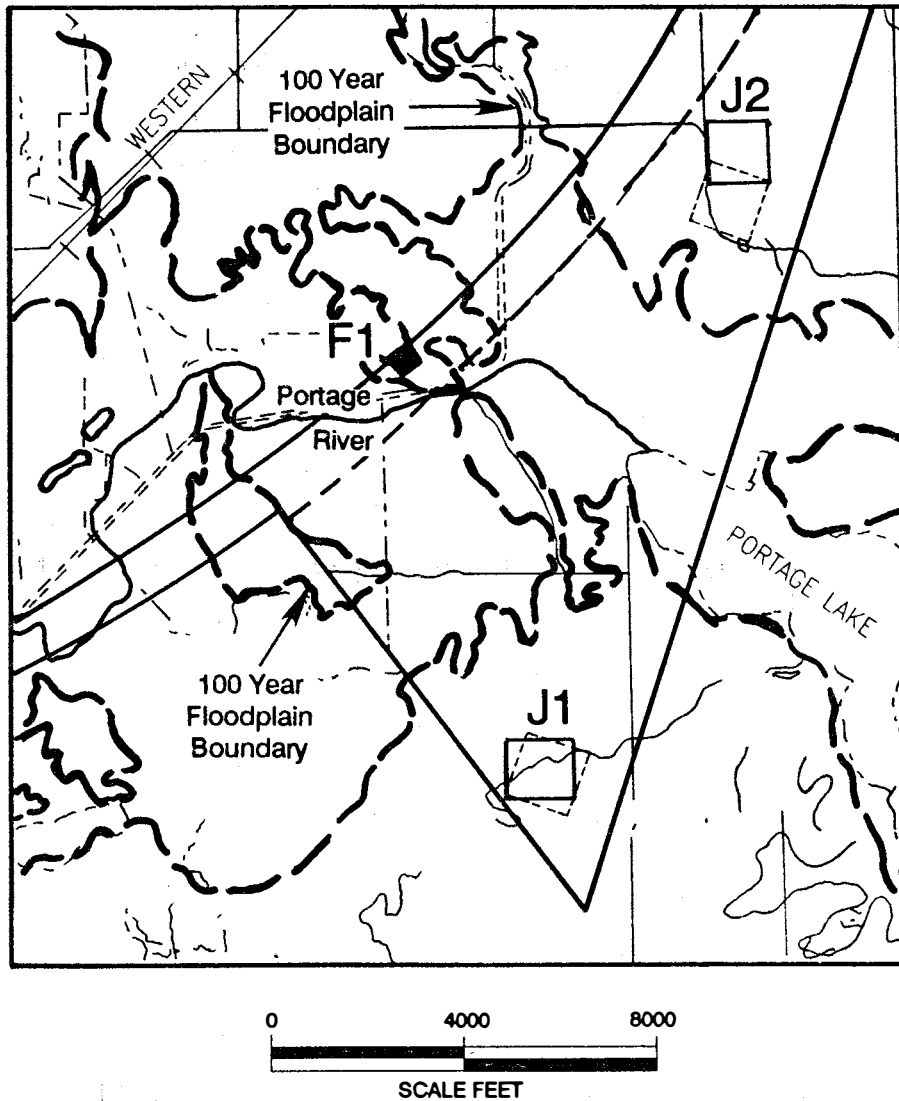


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EIS Volume IV Appendix 7

Source: Menerey, Michigan Department of Natural Resources, 1988.

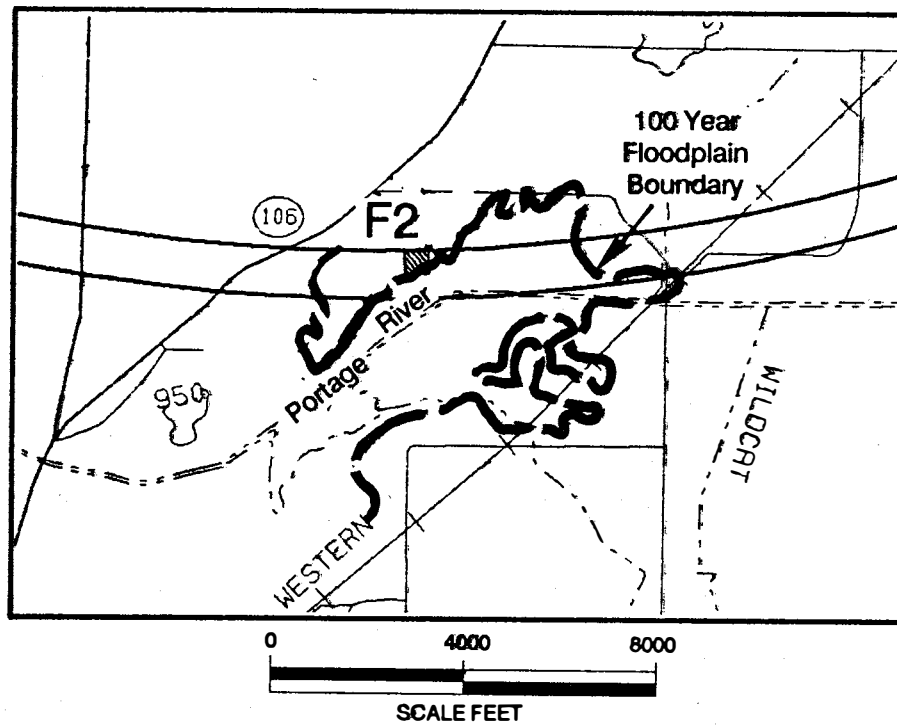
Figure 7-8B  
F1 ENCROACHMENT ON PORTAGE RIVER FLOODPLAIN  
MICHIGAN SITE



Source: Menerey, Michigan Department of Natural Resources, 1988.

Figure 7-8C

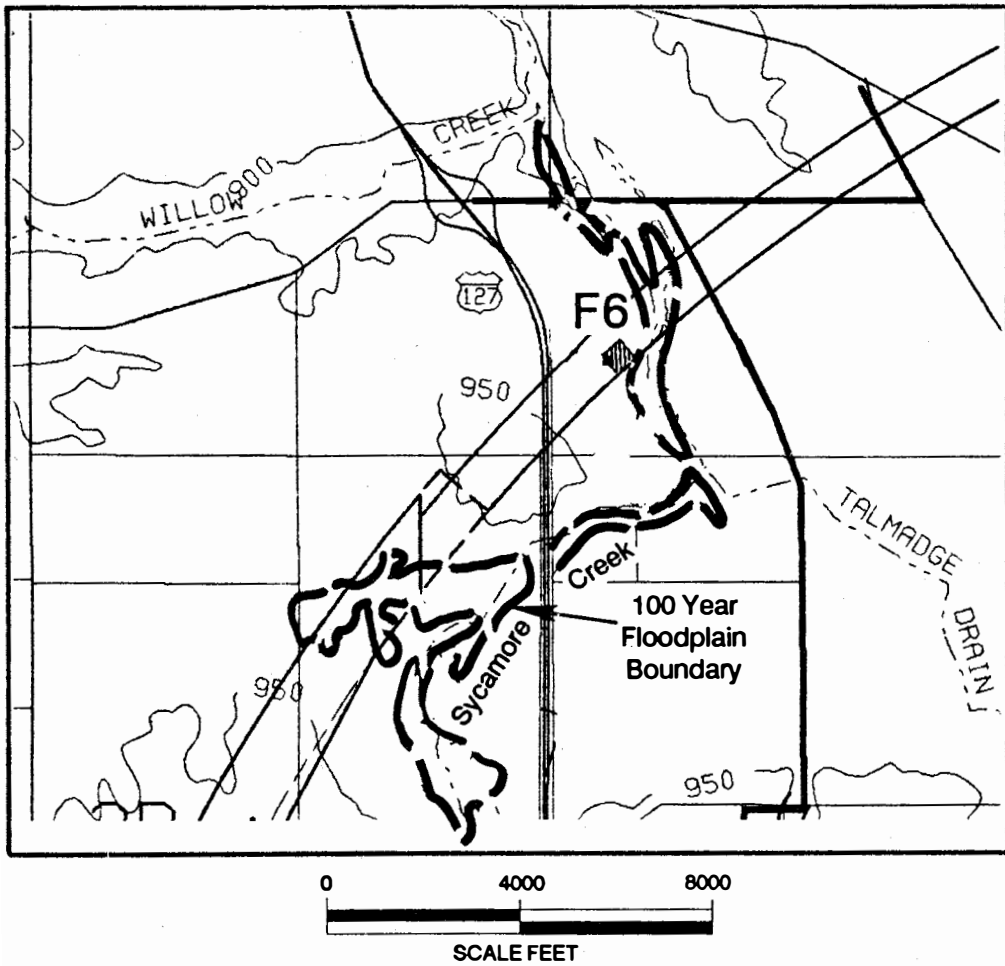
**F2 ENCROACHMENT ON PORTAGE RIVER FLOODPLAIN  
MICHIGAN SITE**



Source: Menerey, Michigan Department of Natural Resources, 1988.



Figure 7-8D  
F6 ENCROACHMENT ON SYCAMORE CREEK FLOODPLAIN  
MICHIGAN SITE



Source: Menerey, Michigan Department of Natural Resources, 1988.

#### D. Surface Erosion

The climate, hydrologic conditions, and areas of disturbance of the Michigan site described in Section 7.1.3.4.A would also have a bearing on the potential for surface erosion. Additionally, topography of the disturbed areas, and their nearness to stream channels, would affect this impact. The Michigan site has very little relief (<250 ft), and very shallow slopes in its glaciated terrain. The campus and injector complex have Thornapple Creek flowing through the middle of the most heavily disturbed area in the SSC project. Outside this area, service areas F1, F2, and F6, and access area E2 are located near channels; F6 is next to Sycamore Creek, and the rest are adjacent to Portage River.

Construction activities in any of these areas could cause a locally measurable increase in surface erosion, and transport of sediment to the natural stream system. A properly installed and well-maintained sediment trap and sediment basin system could be effective in reducing these impacts to negligible levels. However, if a less than ideal system is realized, some impacts may occur on short stretches of Thornapple Creek, Portage River, and Sycamore Creek. These impacts would consist of somewhat higher-than-normal sediment loads and deposition in stream reaches hundreds of feet long. This would be a short-term impact, lasting only during construction, and would not be significant. They would not have an impact as far downstream as Orchard Creek, the Grand River, or Red Cedar Creek. Other related SSC facility construction disturbances such as new roads, improved roads, railroad lines, water lines, sewer lines, gas lines, and electric lines are all potential erosion sources. These are all linear features that would cross watersheds and would be more easily controlled for erosion and sedimentation. Thus, their impact is expected to be negligible.

Regional impacts from surface erosion would be negligible even without mitigation. The Grand River at Lansing includes almost the entire SSC project in its drainage, as well as a sizable portion of the regional drainage. The approximate surface disturbance for the entire SSC project would be about 1,080 acres, or approximately 2 mi<sup>2</sup>, while the Grand River drainage is 1,230 mi<sup>2</sup>. Thus, locally important erosion impacts diminish quickly when considered on the regional scale.

#### E. Channel Erosion

Channel erosion impacts are directly related to runoff increases, and the nature of the channel receiving the greater runoff amounts. Michigan stream channels in the vicinity of the proposed SSC site have abundant fine material in their banks, and are relatively stable. Channel erosion impacts would be greatest on Thornapple Creek downstream from the campus and injector complex. Other areas of surface disturbance are smaller and less concentrated than the campus. These would cause negligible surface runoff increases, and would result in negligible channel erosion impacts to the streams and rivers draining the proposed SSC location. Facility infrastructure would require new transportation

access and utility lines that could affect channel erosion if it is great enough to increase surface runoff. This is expected to be a negligible impact.

## F. Water Quality

### 1. Construction

Impacts to surface water quality caused by the SSC facility may come from surface erosion, channel erosion, pollutant washoff, dewatering the tunnel, increased wastewater treatment plant effluent, and leachate runoff from tunnel spoils piles. While most of these impacts would be directly from SSC development, some may result indirectly from immigration of people relocating to the area of the SSC facility.

Surface erosion would be a measurable impact on only a few short reaches of stream in the project area, as described in Section 7.1.3.4.D, Surface Erosion. This may produce a measurable impact to the water quality of these streams in these reaches but probably not beyond. Such an impact would be short-term and negligible.

Dewatering or removal of groundwater inflow from the tunnel at the Michigan site would include treatment with carbon filtration and reinjection into the ground (see Appendix 10, Section 10.2.3.4.B for details). Because there would be no discharge to surface waters, no water quality impacts are expected from dewatering tunnel construction.

Disposal of tunnel spoils would have three general options, as described in Appendix 10, Section 10.2.3.4.A. These options are: 1) reuse of inert materials, 2) disposal of inert materials in quarries, and 3) disposal of leachable material in landfills. Potential water quality problems with these options could be caused by the stockpiling process where erosion of the pile can occur, leading to off-site transport of sediment. This could be a significant impact without proper containment using perimeter berms and detention or retention basins. Even with good containment, there may still be residual impacts. However, this would be short-term and may not be significant if stockpiling is minimized. Ultimate storage or disposal of nonleachable materials in landfills would result in a negligible impact to water quality, because of the drainage containment. Tunnel spoils with potentially high levels of leachable materials would be about 5 to 15 percent of the total. Potentially leachable materials are sulfur, pyrite, and gypsum. Tunnel spoils would be stockpiled and analyzed for leachable materials. If determined to be inert, they would be transported to quarries for reuse or disposal as fill. If they are determined to have unacceptable levels of deleterious materials, they would be transported to existing Type II or Type III landfills for controlled disposal. Stockpiling this material would last no more than one or two weeks and no leachate production is expected over this short period of time. Landfills have permits because they can demonstrate surface and groundwater controls

that would contain this material. Therefore, disposal of potentially leachable materials in landfills should cause a negligible impact to surface water quality.

Wastewater treatment plant increases caused by in-migration would occur primarily in Ingham and Jackson counties. SSC-induced population increases expected by the peak of construction activity in 1992 would be approximately 3,100 people in Ingham County and 1,700 in Jackson County. Assuming a 100 gal/d/capita increase in wastewater, the increased load on the sewage treatment plants in each county would be 310,000 gal/d and 170,000 gal/d respectively. This represents about 1 percent of the combined available excess capacity in Ingham County, and 2 percent of Jackson County's available excess. Because this increase is within the permitted excess capacity of existing wastewater treatment systems, it should have a negligible impact on surface water quality (Michigan Department of Natural Resources, Surface Water Quality Division 1988).

## 2. Operations

The only area of concern for surface water quality impacts during SSC operations is discharging wastewater and/or cooling tower blowdown into surface water. Cooling tower blowdown could be handled by vacuum compression units, or by combining it with sewage and transporting it to existing wastewater treatment plants. The first process would be self-contained and has no discharge to surface waters and no impact on water quality.

The second option could send approximately 100,000 to 150,000 gal/d to the Stockbridge treatment plant. Another 150,000 gal/d of sewage from the campus area would also be treated. The existing available capacity at the Stockbridge plant is about 40,000 gal/d of primary treatment (Michigan Department of Natural Resources, Surface Water Quality Division 1988). The state has proposed to expand and upgrade the treatment plant, acknowledging that the available capacity would be exceeded with this demand. This expansion would require a change to the existing NPDES permit, or a new permit. This would be a measurable impact to the receiving water quality. However, if the system were upgraded to tertiary treatment, as required by the ISP, water quality impacts may not be significant. Other SSC areas will use septic tanks, dosing tanks, and leachate fields.

Off-site population increases would also place a demand on wastewater treatment plants primarily in Ingham and Jackson counties. Projected population increases caused by SSC operations are about 2,400 people in Ingham County and 1,400 in Jackson County. Assuming 100 gal/d/capita increase in each of these counties, the increase in wastewater treatment demand would be about 1 percent and 2 percent of the combined available excess plant capacity in Ingham and Jackson counties, respectively. This increase is within the existing, permitted capacities in these counties, so it should have a negligible impact on surface water quality (Michigan Department of Natural Resources, Surface Water Quality Division 1988).

## G. Surface Water Use

### 1. Construction

The proposed construction water supply at the Michigan site would be groundwater. General water use during construction has been estimated for the period 1989 to 1995 for the facility, and is included in Table 7-1. Off-site water use during the same period has been estimated by county and is presented in Table 7-5. Since use of surface water has not been proposed for any of the construction activities, direct impacts to surface water use should not occur. Indirect off-site water use increases may occur for the Ann Arbor water supply system because of the in-migration predicted for Washtenaw County. This system is supplied mainly by surface water (about 80 percent), and had a total use in 1984 of about 18,000 acre-ft. The peak water use during construction is predicted for 1992 at about 180 acre-ft, or about 1 percent of the current supply.

An alternative source of water for both direct and indirect uses is the abundant surface water that is characteristic of the region and generally underdeveloped. For example, the average discharge of the Grand River at Eaton Rapids was 462 ft<sup>3</sup>/s during the period from 1950 to 1982. This is an average annual discharge of approximately 334,400 acre-ft/yr. Mean monthly flows are as low as 138 ft<sup>3</sup>/s or 10,000 acre-ft/month for the month of September (Heinzman 1988). Some percentage (less than 40 percent) of this flow is used for cooling at electric power plants near Lansing.

Annual water withdrawals for all major uses in Ingham County are estimated at 485 acre-ft/day. Of this, 78 percent (378 acre-ft/day) is from surface water sources. Most surface water withdrawals occur in the northern part of the county at some distance from the Stockbridge site, primarily from four thermoelectric power plants in the Lansing/East Lansing area. Three of the nine public water supply systems in Ingham County are located near the Stockbridge site. However, these and other municipal water supply systems in the county rely entirely on groundwater withdrawals (Van Til 1988).

Annual water withdrawals for all major uses in Jackson County are estimated at 58 acre-ft/day. Of this, 11 percent (6.4 acre-ft/day) is from surface water sources. There are no thermoelectric power plants in the county; therefore, overall water withdrawals are significantly lower than for Ingham County. Thirteen public water supply systems are operated throughout Jackson County, generally in the central and southern parts of the county at some distance from the Stockbridge site. These systems rely entirely on groundwater rather than surface water withdrawals (Van Til 1988).

Table 7-5

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
DURING SSC CONSTRUCTION AND OPERATIONS  
IN MICHIGAN<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)							Water Use During Operations (acre-ft/yr)
	1989	1990	1991	1992	1993	1994	1995	
Ingham County	40	160	290	310	280	305	260	195 - 245
Jackson County	20	80	160	175	155	170	145	110 - 140
Washtenaw County	25	90	165	180	160	175	150	110 - 140
Other Nearby Counties <sup>2</sup>	<u>1</u>	<u>5</u>	<u>10</u>	<u>10</u>	<u>10</u>	<u>10</u>	<u>10</u>	<u>5</u>
TOTAL	86	335	625	675	605	660	565	420 - 530

1. Estimated domestic water use is based on population projections multiplied by a factor of 90 gal/d/capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Michigan. The estimates do not include water delivered for industrial and commercial use.
2. Includes estimates for Calhoun, Eaton, Hillsdale, Lenawee, Livingston, Shiawassee, and Wayne counties.

## 2. Operations

Groundwater has been proposed as the source for all SSC operations water use. Expected on-site and off-site water use is presented in Tables 7-1 and 7-5. No on-site, operational surface water use is proposed. In the region near the SSC site, only the Ann Arbor water supply system currently uses surface water sources. Potential increases in water use in Washtenaw County are expected to be about 110 to 140 acre-ft/yr. This represents a very small portion of the current water use in the county (<1 percent of the 1984 water use).

### 7.1.3.5 North Carolina

#### A. Surface Runoff

The North Carolina site is located in a rural area of the Piedmont Physiographic Province. Hydrologic conditions are fairly typical of the Piedmont; low to moderate relief with a well-distributed stream channel network, and good drainage. The hydrologic features that could be impacted by surface disturbance are shown in Figure 7-9.

Total disturbed area anticipated at the North Carolina site is about 1,915 acres. Surface areas disturbed would include about 480 acres in the campus and injector complex, and another 80 acres for primary facilities spread around the ring. The campus and injector areas are drained by Knap of Reeds Creek, and a tributary to Knap of Reeds Creek known as Camp Creek. These streams are tributary to Lake Butner. They have a combined drainage area of almost 16 mi<sup>2</sup>, which would make the disturbed area about 5 percent of the total watershed. A substantial amount of rainfall occurs in the area (about 46 inch/yr), well distributed throughout the year. Thunderstorms occur on the average of 62 times per year. Thus, a change in surface characteristics could affect runoff.

The disturbed area in the campus and injector complex could have a measurable impact on runoff and increase flows in Knap of Reeds Creek. However, with the use of detention and retention basins, the residual impacts of increasing runoff could be kept negligible. The other disturbed surfaces associated with the SSC facility construction would represent a much smaller percentage of other drainage areas, and they would cause only negligible impacts. Regionally, the primary SSC project facility and the secondary housing development for project personnel would cause some surface disturbance, but these would represent a very small percentage of regional watershed areas and should cause only a negligible impact to runoff.

#### B. Drainage Network

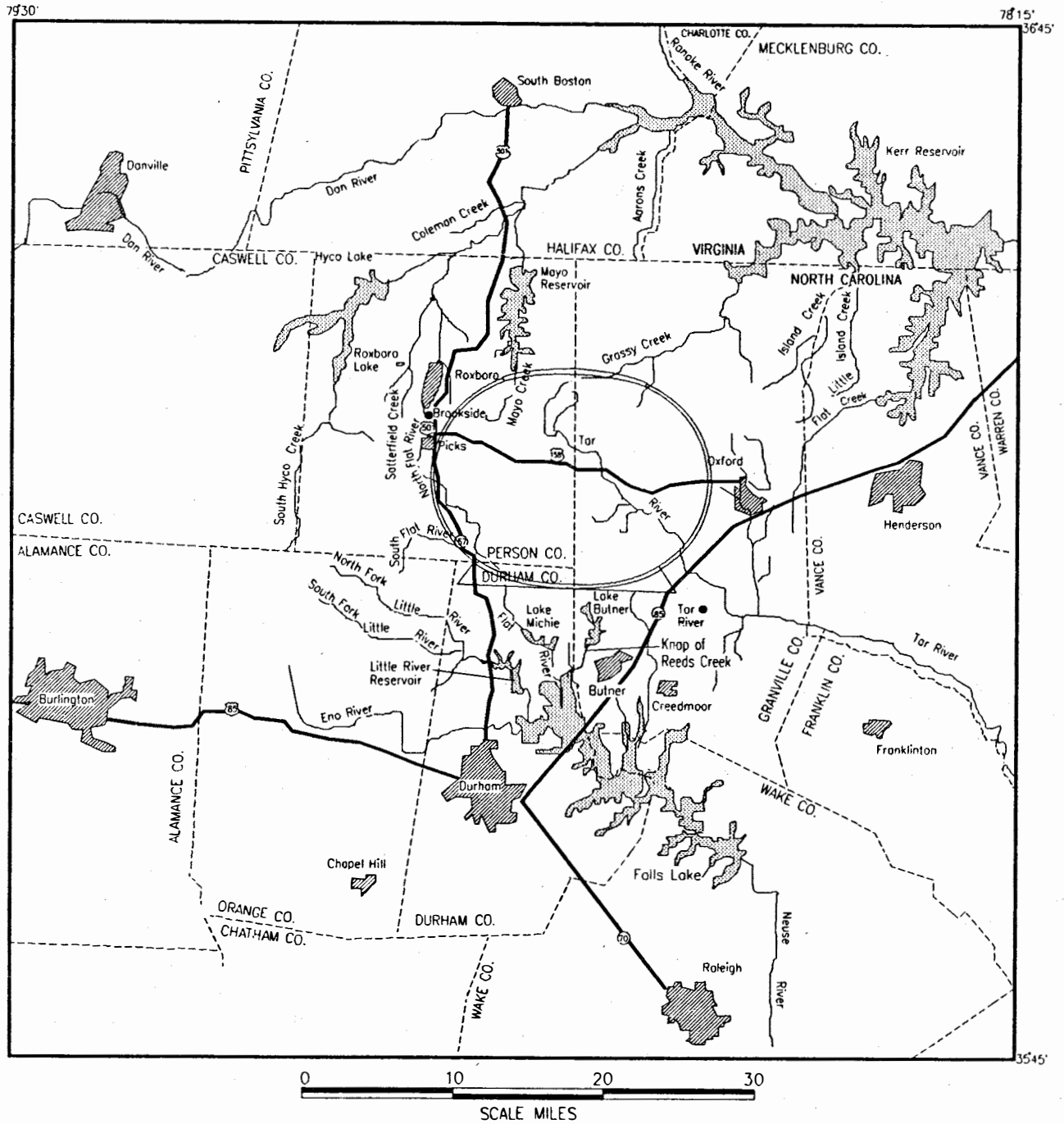
Construction of the injector and booster tunnel complex would require approximately 6.5 mi of cut-and-fill operations, which would cross Knap of Reeds Creek three times and tributaries four times. Each channel crossing would require some type of temporary stream channel diversion, which would probably be less than 500 ft in length. Each of these diversions would not involve any real change in drainage area. With proper staging and other protection measures, the residual impact from these drainage pattern modifications should be negligible. No other facilities around the ring should require any drainage pattern modifications during the construction period, and they should have no impact.

Regional impacts from drainage modification would be negligible. The injector and booster areas stream diversion would have a very localized effect, and secondary drainage modification for housing development should be very limited, thus, a negligible regional impact.



Figure 7-9

HYDROLOGIC FEATURES - NORTH CAROLINA SITE



### C. Floodplains

All three counties in which the SSC facility would be located are included in the national flood insurance program. However, only Durham County is mapped to the detail of the FEMA Flood Insurance Rate Maps. Granville and Person counties are only shown on Flood Hazard Boundary Maps. The lack of complete coverage by FEMA Flood Insurance Rate Maps indicates a low potential for flood damage to occur on any improved properties. The area is rural with little development in the form of houses or other buildings. During preconstruction analyses, geotechnical and other environmental studies would be performed to verify these data as part of final project design.

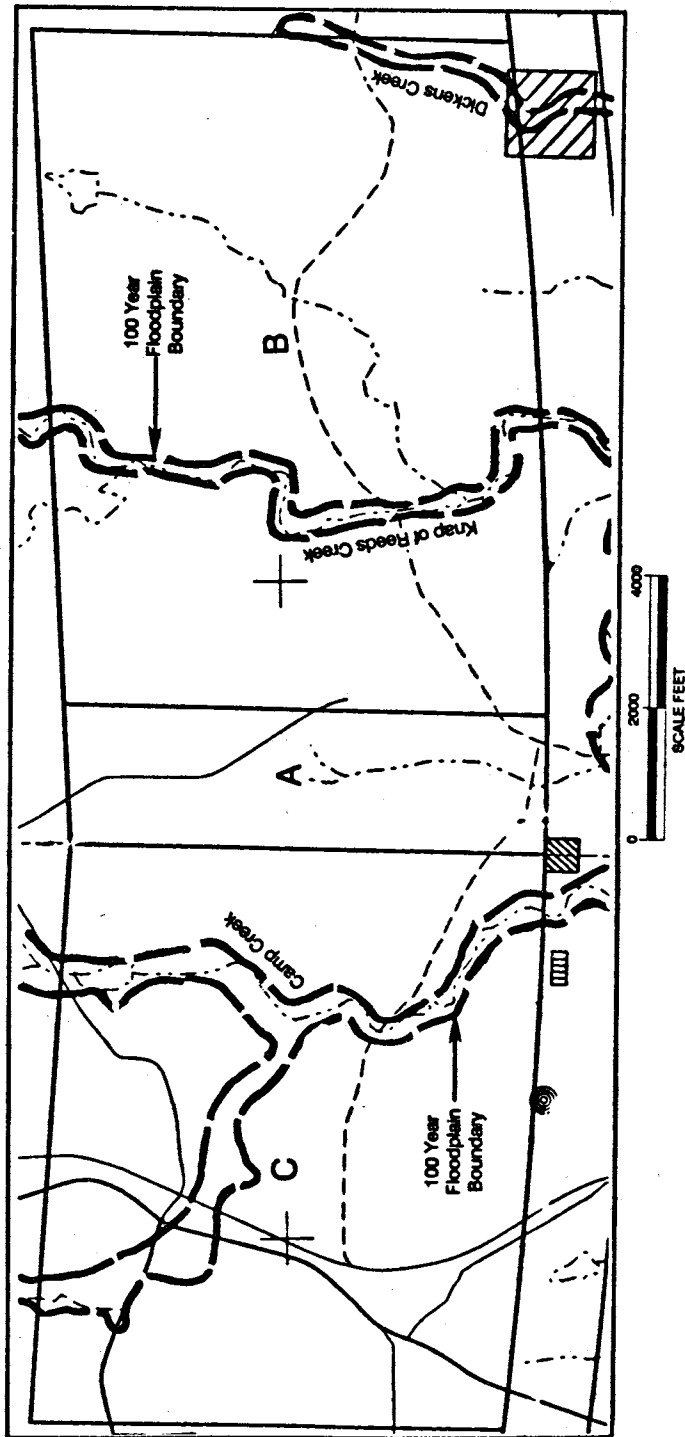
In preparing this floodplain assessment, the available FEMA maps were used to determine whether any of the proposed facilities would be in the 100-yr floodplain (FEMA 1978a, 1978b, 1979). DOE has initiated informal consultation with the Wilmington District Corps of Engineers concerning floodplain encroachment (Woodbury 1988).

Temporary floodplain encroachment is inevitable from construction and operation activities in area B, the injector complex, and from future activities in area C (Figure 7-9A). Other areas with potential floodplain involvement include: access area E2 (Figure 7-9B); beam access area J6 (Figure 7-9C); experimental hall K6 (Figure 7-9D); beam access area J5 (Figure 7-9E); and beam access area J2 (Figure 7-9F). Beam access area J6 and experimental hall K6 both show potential encroachment exceeding 90 percent of the floodplain. The upstream watershed in both cases, however, is small (J6 - 3 mi<sup>2</sup>; K6 - 1.3 mi<sup>2</sup>), therefore mitigation activities should reduce or eliminate any upstream flooding impacts. Beam access area J2 has a large upstream watershed area (141 mi<sup>2</sup>), but along with beam access area J5 and access area E3, these areas only show minor encroachment into the floodplain and are not likely to create upstream flooding. Because the existing floodplain mapping of these locations, with the Flood Hazard Boundary Maps, is not detailed enough to make measurements of floodplain encroachment, no actual numbers are given. These encroachments could all produce impacts including local flooding of their adjacent streams if the encroachment is great enough. Encroachment on Knap of Reeds Creek from the injector and booster complex (Area B) can be mitigated with levee or berm construction during cut-and-fill operations. The residual floodplain encroachment impacts here would then be negligible. Encroachments at the other locations may be avoided through adjustments of the final facility location. If this is not possible, mitigation with levees is also an alternative. In either case, the residual impact would be negligible.

Construction of new roads to provide access to the SSC facility would be extensive for the campus area. A total of 23.3 mi of new four- to six-lane roadways would be constructed to provide easier access to the campus area. These roadways would cross the Flat River, Dial Creek, and Camp Creek, as presently located. To make the desired connections to other

Figure 7-9A

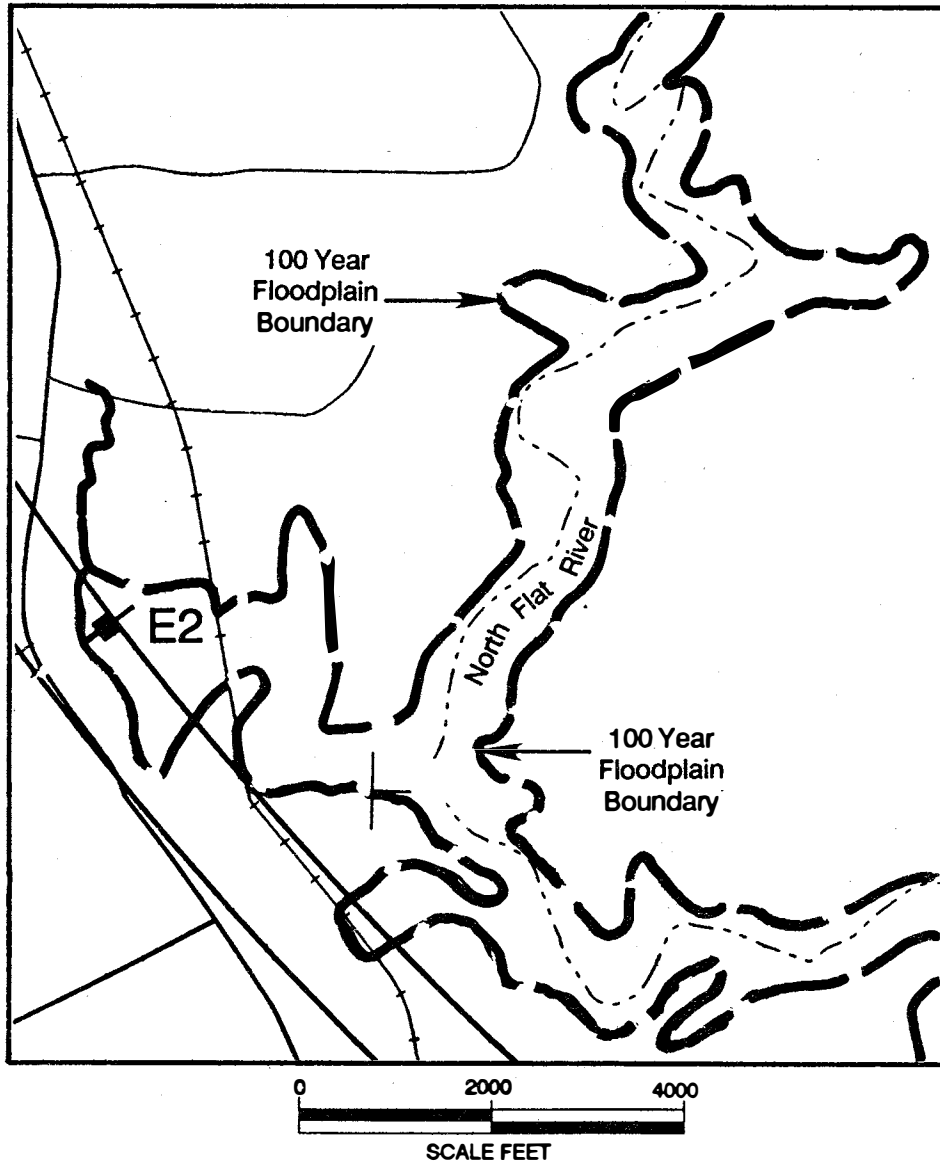
**AREA C AND B ENCROACHMENTS ON CAMP CREEK,  
KNAP OF REEDS CREEK, AND DICKENS CREEK FLOODPLAINS  
NORTH CAROLINA SITE**



Source: Federal Emergency Management Agency, 1978a and 1979.

Figure 7-9B

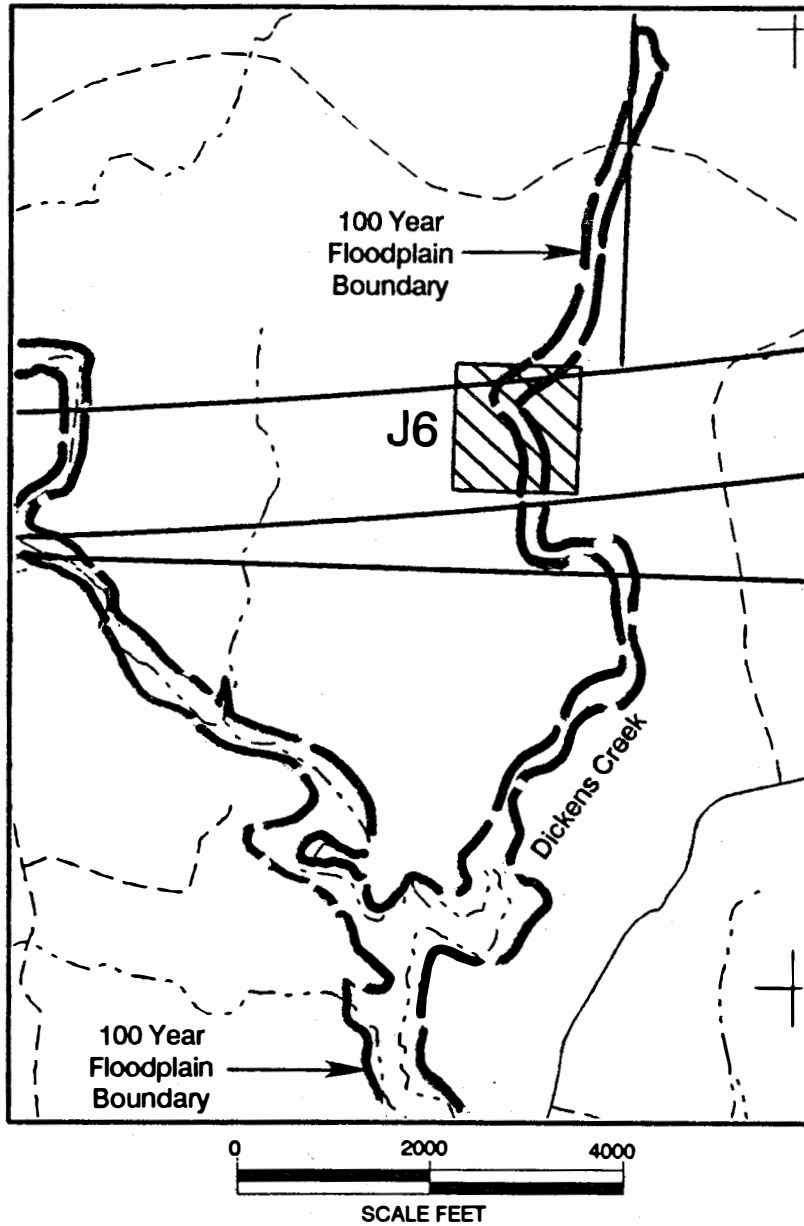
**E2 ENCROACHMENT ON NORTH FLAT RIVER FLOODPLAIN  
NORTH CAROLINA SITE**



Source: Federal Emergency Management Agency, 1978b.

Figure 7-9C

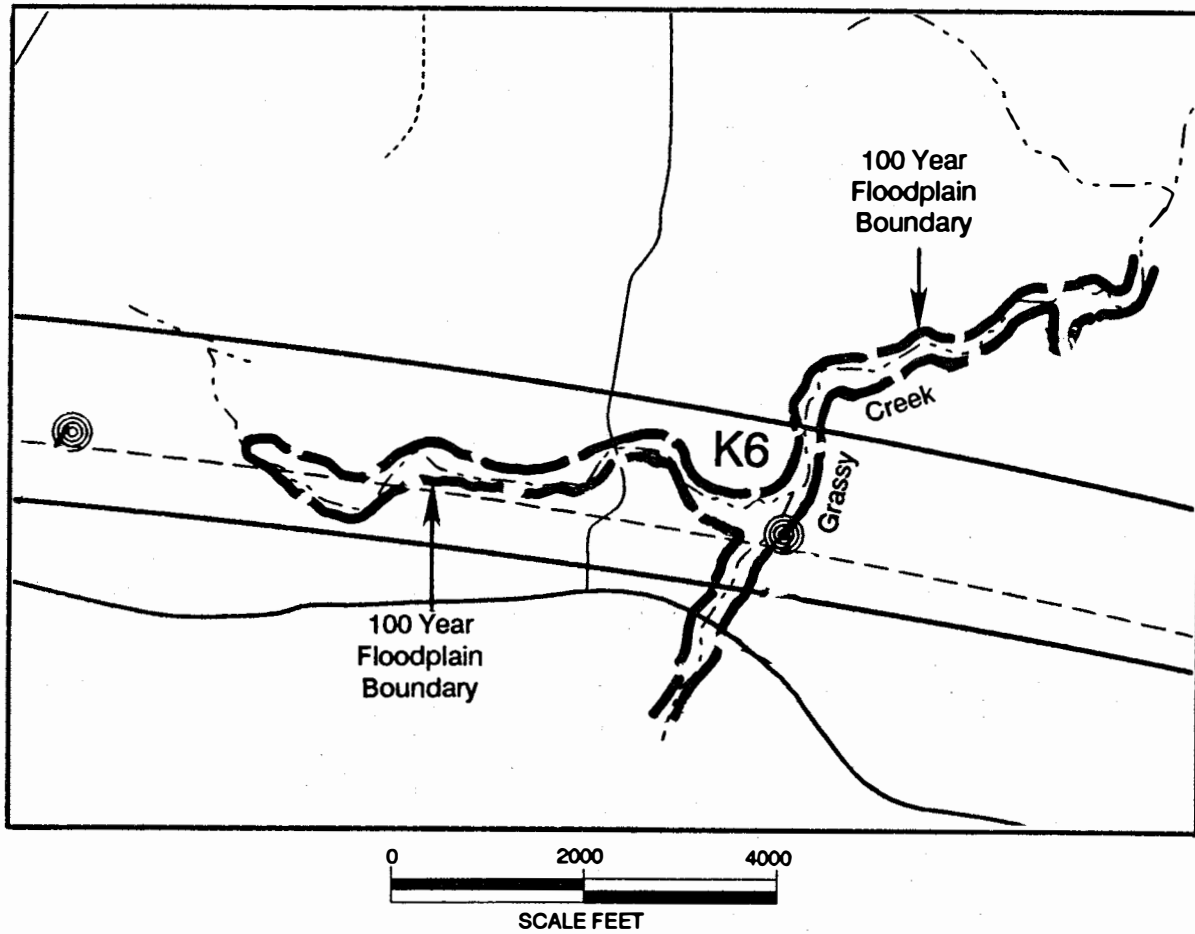
J6 ENCROACHMENT ON DICKENS CREEK FLOODPLAIN  
NORTH CAROLINA SITE



Source: Federal Emergency Management Agency, 1978a.

Figure 7-9D

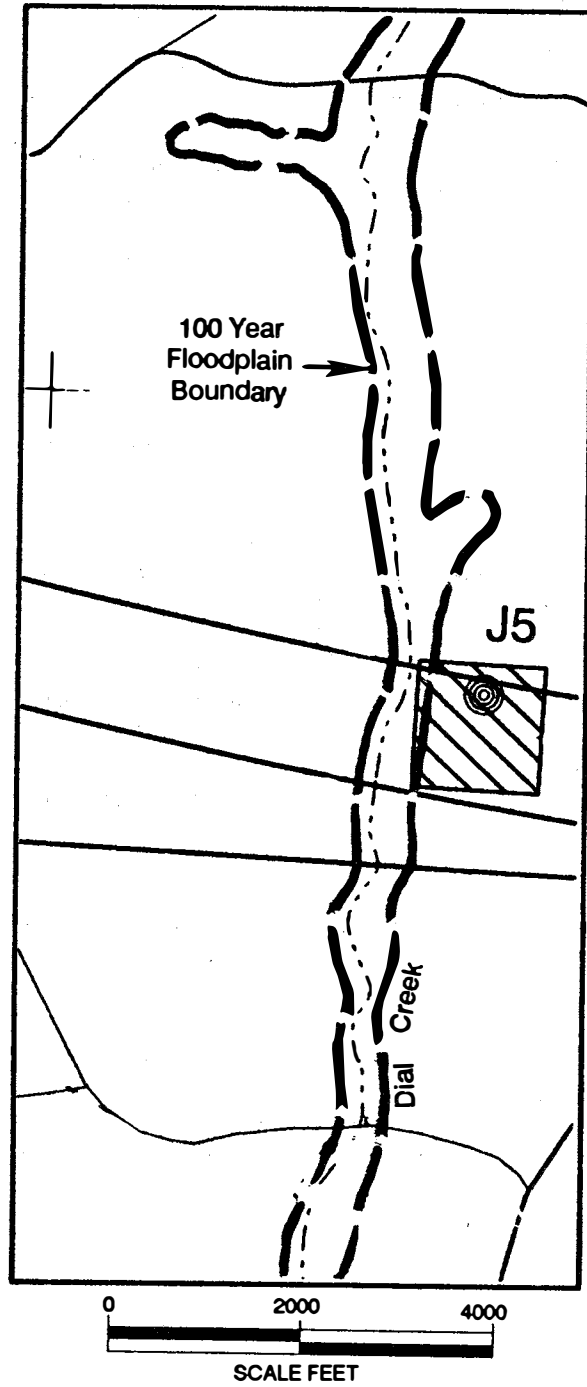
**K6 ENCROACHMENT ON GRASSY CREEK FLOODPLAIN  
NORTH CAROLINA SITE**



Source: Federal Emergency Management Agency, 1978a.

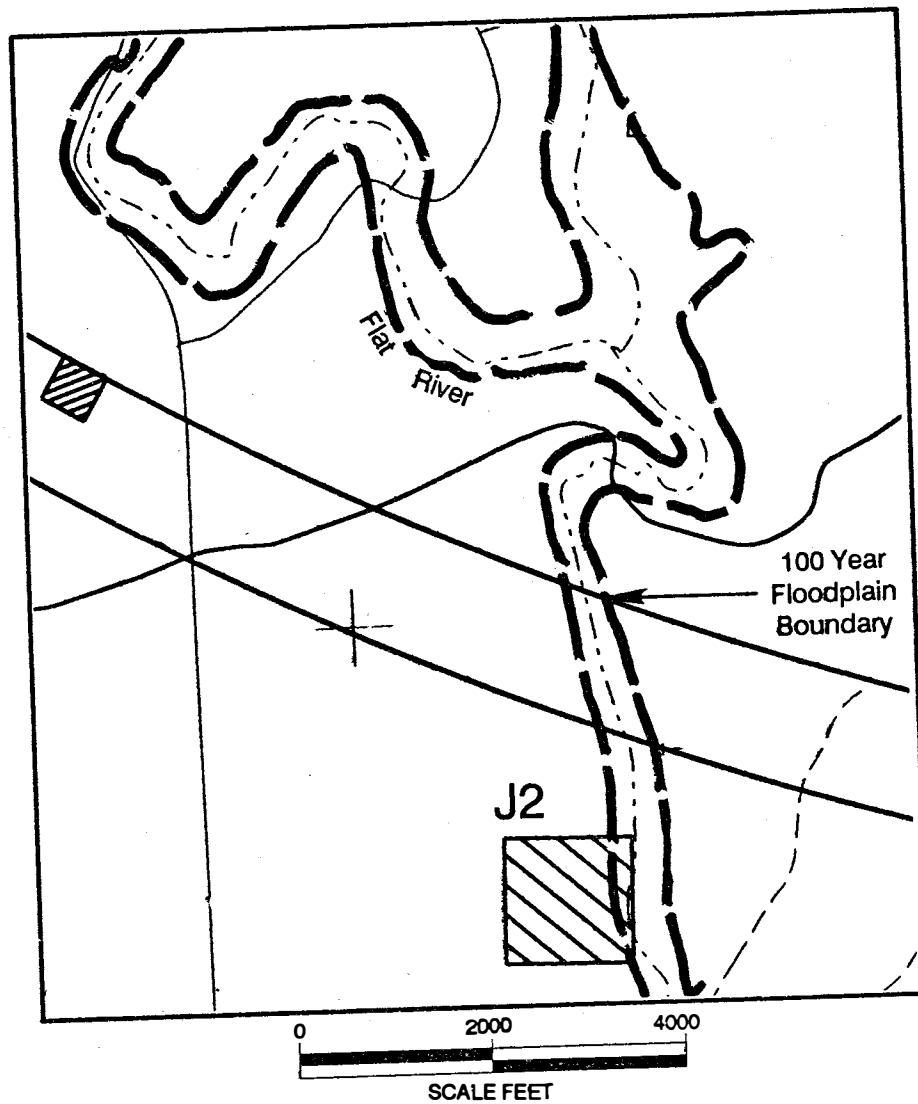
Figure 7-9E

J5 ENCROACHMENT ON DIAL CREEK FLOODPLAIN  
NORTH CAROLINA SITE



Source: Federal Emergency Management Agency, 1979.

Figure 7-9F  
J2 ENCROACHMENT ON FLAT RIVER FLOODPLAIN  
NORTH CAROLINA SITE



Source: Federal Emergency Management Agency, 1979.



existing roads and the campus, these stream crossings cannot be avoided. An additional 12.3 mi of new, two-lane paved access roads would be built for the other facilities around the ring. Most of these roads are in short stretches of less than 1 mi, one of which may cross Grassy Creek, to connect with experimental hall K6. This stream crossing may not be necessary, depending on the final road location. A total of 1.3 mi of new one-lane gravel roads would be built to provide access to the intermediate access areas (E1 through E9). None of these short roads are expected to cross any identified stream channels. If proper care is taken in roadway fill placement and culvert or bridge design, these floodplain crossings would have a negligible impact to upstream flooding.

In general, floodplain encroachments only impact upstream flooding by constricting the floodplain, causing backwater effects. This is more of a problem on larger streams with shallower slopes than smaller or steeper streams. Only two of these potential encroachments are on streams with watersheds greater than 20 mi<sup>2</sup>, the South Flat River (at E2), and the Flat River (at a new four-lane highway crossing). Both of these have relatively small watersheds of less than 150 mi<sup>2</sup>, and regional impacts from floodplain encroachment on these streams would be negligible.

#### D. Surface Erosion

As described with greater detail in Section 7.1.3.5.A, Surface Runoff, the climate of the North Carolina site has a moderate amount of precipitation, with a sizable number of thunderstorms providing intense rainfall, primarily in summer. The site is also well drained with moderately steep topography. The campus and injector areas would have the greatest concentration of disturbed land surface exposed to erosion during the construction period, with smaller amounts disturbed for the construction of other facilities around the ring. In addition to Knap of Reeds Creek with the campus disturbance in its watershed and close to its channel, Flat River and South Flat River, Dial Creek (all tributary to the Neuse River), and Grassy Creek (tributary to the Roanoke River), all have SSC facilities in the vicinity of their channels.

These disturbances could cause a measurable increase in surface erosion and sediment transport to limited reaches of each of these channels. A properly installed and well-maintained sediment basin and trap system could be effective in reducing these impacts to negligible levels. Unfortunately, if the system is less than ideal, some impacts may occur on short stretches of the Flat River, South Flat River, Dial Creek, Dickens Creek, and Grassy Creek. The impact would consist of somewhat higher-than-normal sediment loads and deposition in stream channel reaches hundreds of feet long. The impact to Knap of Reeds Creek could be worse, with significantly higher sediment loads and deposition, because of the large proportion of disturbed area. However, all of these impacts would be short-term, construction-period impacts, and except for the Knap of Reeds Creek, they would not be significant. Surface erosion impacts may well be significant on Knap of Reeds Creek because of its nearness to the disturbed area.

Other SSC construction activities would cause disturbances with road construction and improvement, and new water, sewer, gas, and electric lines to be installed. Because these are all linear features that traverse different watersheds, erosion and sediment control and containment can be quite effective. Therefore, mitigation with silt fences, berms, and other measures should reduce these impacts to negligible levels.

The 17 proposed surface disposal sites for tunnel spoils would have some potential for erosion and transport of sediment off site. Four factors affect this potential: topography, surface area of spoils, amount and type of rainfall, and nearness to streams. The spoils disposal sites were selected to minimize off-site transport of sediment using criteria such as requiring slopes less than 6 percent, and natural forested buffers surrounding the sites. This would tend to offset other factors such as a relatively high annual rainfall [about 46 inch/yr (U.S. Environmental Science Services Administration 1968)], with potential for high-intensity rains [about 62 thunderstorms per year (U.S. Weather Bureau 1961)], nearness to streams at most sites, and a surface area of about 75 acres of spoils. The impact of these disposal sites on surface erosion would be measurable, and could be significant on short stretches of channel immediately downstream from disposal sites. These would be mostly small tributaries of streams in the Tar and Flat River basins. This should be only a short-term impact, however, lasting until vegetation can stabilize the disposal piles.

#### E. Channel Erosion

Runoff increases are expected to be minor, especially after retention and detention basins are employed. Natural stream channels in the project vicinity generally have stable banks with adequate amounts of cohesive fine materials to resist channel enlargement. Knap of Reeds Creek and its tributary, Camp Creek, pass directly through the campus and injector areas where disturbances would be the most concentrated. If surface runoff mitigation were not planned, measurable impacts from channel erosion might occur as a result of increased runoff. However, surface runoff would be mitigated, as described in Section 7.1.3.5.A, and channel erosion impacts should thus be negligible. Other channels draining the ring area would contain far less disturbed land, thus runoff should not increase measurably in their watersheds, and the impacts from channel erosion on these streams should be negligible.

Regional impacts from channel erosion because of direct SSC activities would also be negligible. Any increases in channel erosion would be localized near the new SSC facilities and transportation and utilities rights-of-way, and these would be negligible when considered as part of the larger Neuse, Roanoke, or Tar river basins of the region.

## F. Water Quality

### 1. Construction

Impacts to surface water quality may come from surface erosion, channel erosion, pollutant washoff, dewatering the tunnel, and increased wastewater treatment plant effluent. Most of these would be a direct result of the SSC development; some may also result indirectly from in-migration of people for the facility.

Surface erosion would result in a measurable impact on only a few short reaches of stream in the project area, as described in Section 7.1.3.5.D. This may produce an impact to the water quality of these streams in these reaches, but probably not beyond. Such an impact would be short-term and not significant.

Dewatering of tunnel construction operations would occur with the water discharged into one or two sedimentation ponds. Water in the ponds then may be discharged to the nearest stream system, used for construction, or reinjected into the groundwater. Reinjecting water should not impact surface water quality. Water used for construction is not assessed here because it was considered under construction activity impacts (surface erosion) and pollutant washoff impacts to water quality. Water discharged to natural stream systems may cause a measurable impact if the sedimentation ponds are not effective. This would impact only short stream reaches, would not be a significant impact, and would be short-term, during construction only.

Tunnel spoils would be disposed of at nearby locations selected with several important criteria to minimize erosion and transport of spoils material. In addition to, or possibly instead of these sites, spoils material may be sold or given to local aggregate producers. Use of the latter option would cause only a negligible impact to surface water quality in the area because the controls are already enforced at aggregate production plants.

The nearby disposal sites would produce some sedimentation in local streams, as discussed in Section 7.1.3.5.D. Such sedimentation also causes impacts to the water quality of these streams by increasing turbidity, nutrient levels, and other constituents in the water. Impacts to surface water quality from this disposal option would be measurable for relatively short stretches ( $\leq 1,000$  ft) during the period of construction. Degradation of water quality would be worst during individual runoff events, and would improve as flows return to base flow conditions. During these worst conditions the water quality impact would be significant, but this is generally a transient condition. No potential for leaching deleterious materials from spoils has been identified.

Increases in wastewater treatment plant discharges caused by the SSC facility could occur at several treatment plants. Expected population increases in the service area can be used to estimate an increase in the load to these systems.

The expected population increases in Durham, Granville, and Person counties caused by in-migration during construction would be about 4,600, 900, and 400 respectively by the peak year 1992. Assuming an increase in wastewater of 100 gal/d per person, the increased demand in these counties would be 460,000 gal/d, 90,000 gal/d, and 40,000 gal/d respectively. Currently, there is no available excess treatment capacity from the combined Durham County treatment plants. However, an expansion is planned as described in Appendix 5, Section 5.5.8.1, which would increase the available capacity by at least 8 million gal/d. Therefore, the increased off-site demand from the SSC project should be less than 10% of the remaining available capacity by 1992. Granville County currently has a total available capacity of 1.16 million gal/d, primarily from three treatment plants. This would be more than enough to treat the expected off-site increases in wastewater. Person County has no available excess capacity, and no plans to increase the only plant currently handling wastewater. Thus, the expected increase in wastewater would force expansion of the Roxboro treatment plant in Person County or force the construction of a new one (North Carolina Division of Environmental Management, Water Quality Planning Branch 1988).

The increase in wastewater treated by plants with available capacity in Durham and Granville counties should have a negligible impact on water quality. The increases in Person County would require expansion in capacity, and would require a new NPDES permit or a change in an existing one. This would cause discharges to Marlow Creek, tributary to the Roanoke system, and thus could have a measurable impact on surface water quality to this stream. However, because this additional discharge must be authorized by an NPDES permit, this should help minimize the impact to surface water quality so that it would not be significant.

Regional water quality impacts from direct SSC construction activity would be negligible. All impacts at the site would be localized on short stream reaches, and these effects would be small when the larger Neuse, Roanoke, or Tar river watersheds are considered. Indirect impacts from off-site activities would also be localized and probably not constitute an impact on the regional scale.

## 2. Operations

The only area of concern for impacts to surface water quality during operations is the discharge of wastewater and/or cooling tower blowdown into surface water.

Wastewater and cooling tower blowdown could be handled in different ways for the different facilities. The campus area most likely would combine domestic sewage with cooling tower blowdown and send it to the Butner treatment plant. The far cluster wastewater and cooling tower blowdown could be pumped from the southwest quadrant and sent to the Durham-Eno wastewater treatment plant. The two northern quadrants would be sent to the Oxford-South treatment plant.

The Butner treatment plant, which is expanding, should then have an excess capacity of about 1.1 million gal/d. The direct operations demand would be about 150,000 gal/d for sewage and about 100,000 to 150,000 gal/d from cooling tower blowdown. If all of Granville County is considered and expected off-site wastewater treatment requirements included, the increased demand would be about 385,000 gal/d and the available capacity about 1.16 million gal/d. Thus, increases would be easily handled by the available capacities of the Granville County treatment plants (North Carolina Division of Environmental Management, Water Quality Planning Branch 1988).

The Eno River plant would have the capacity to easily handle the increase in wastewater, but the Oxford-south facility would not. Therefore one logical alternative is a new package treatment plant to handle wastewater and some cooling tower blowdown. This would require a new NPDES permit to discharge into one of the Roanoke River tributaries to the north. The introduction of wastewater discharges into a Roanoke River tributary at the far cluster could have a measurable impact to those surface waters. Tertiary treatment and the NPDES permit requirements would ensure that the impact is not significant. Instead of tertiary treatment, land application systems might be used to dispose of the effluent from the package treatment plant. At the remote service areas, sewage would be disposed of by septic tanks and leach fields.

The increase in treatment effluent at the Butner plant, because it is within the permitted available capacity, should have a negligible impact on the water quality in Knap of Reeds Creek. Alternatively, the campus area wastewater and cooling tower blowdown could be treated by a package plant and subsequently disposed of by land application systems.

Regional water quality impacts from cooling tower blowdown would be negligible. Remaining cooling tower blowdown water will be handled by vacuum-compression brine concentrator or side-stream softeners.

## G. Surface Water Use

### 1. Construction

Proposed water supply for the SSC in North Carolina is principally surface water. Direct construction-period water use requirements expected for the SSC facility, in general, are given in Table 7-1. Indirect domestic water use requirements during construction are given in Table 7-6. The proposed water supply is Lake Butner for the campus and injector complex and near cluster half of the ring, and Mayo Reservoir for the far cluster half of the ring. Lake Butner has a current safe yield of about 10,000 acre-ft/yr, and an available excess of 7,540 acre-ft/yr.

Table 7-6

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
DURING SSC CONSTRUCTION AND OPERATIONS  
IN NORTH CAROLINA<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)							Water Use During Operations (acre-ft/yr)
	1989	1990	1991	1992	1993	1994	1995	
Durham County	80	300	540	565	500	550	490	415 - 550
Person County	5	25	45	50	40	45	40	35 - 45
Granville County	15	55	105	110	95	105	95	80 - 105
Other Nearby Counties in NC <sup>2</sup>	180	560	1,020	1,015	840	875	730	605 - 815
Other Nearby Counties in VA <sup>3</sup>	<u>20</u>	<u>65</u>	<u>120</u>	<u>115</u>	<u>90</u>	<u>90</u>	<u>70</u>	<u>60 - 80</u>
TOTAL	300	1,005	1,830	1,855	1,565	1,665	1,425	1,195 - 1,595

1. Estimated domestic water use is based on population projections multiplied by a factor of 110 gal/d/capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in North Carolina. The estimates do not include water delivered for industrial and commercial use.
2. Includes estimates for Alamance, Caswell, Chatham, Franklin, Guilford, Halifax, Nash, Orange, Rockingham, Vance, Wake, and Warren counties.
3. Includes estimates for Charlotte, Halifax, Lunenburg, Mecklenburg, and Pittsylvania counties.

Mayo Reservoir has a current safe yield of over 22,000 acre-ft/yr, and an available excess of 13,800 acre-ft/yr (Sutherland 1988). The total peak yearly SSC construction period demand would be 88 acre-ft in 1992, or less than 2 percent of the available excess of either of these supply sources.

The estimated peak off-site domestic water use also occurs in 1992. For assessment purposes, it is assumed that the additional demand for water in Durham County would be met by the City of Durham's water supply reservoirs, Lake Michie and the recently completed Little River Reservoir. Additional demands in Granville and Person counties would be met by Kerr Reservoir and Lake Isaac Walton, respectively. The Little River Reservoir has a safe yield of 24,000 acre-ft/yr. Together with Lake Michie, the two reservoirs now provide Durham a combined safe yield of 47,500 acre-ft/yr and an available excess of about 21,700 acre-ft/yr. Therefore, the estimated peak domestic use in Durham County would be less than 3 percent of the excess. The construction of the SSC at the proposed location may impact the City of Durham's future intention of impounding the Flat River for water supply purposes. Impoundment of the Flat River may inundate some portions of the proposed SSC site. Potentially inundated areas would include J2 which is near the river at an elevation of about 400 feet and would be below the planned pool elevation.

The current available excess from Kerr Reservoir is about 3,500 acre-ft/yr. The estimated peak domestic use increase in Granville County would be less than 4 percent of this excess. In Person County, the estimated peak domestic use increase in 1992 would be less than 2 percent of the current available excess water in Lake Isaac Walton, currently about 4,700 acre-ft/yr. The increased demand in other North Carolina counties, and other Virginia counties, would be spread over as many as 12 counties, and probably no one system would experience more than 100 acre-ft/yr of additional domestic use. For all counties, the impacts from the combined effects of direct SSC construction use of water and off-site increases in domestic water use should be negligible (Sutherland 1988).

## 2. Operations

The expected operations water use of the SSC facility would be 460 acre-ft/yr from Mayo Reservoir and 1,715 acre-ft/yr from Lake Butner (Table 7-1). This is less than 4 percent of the available excess water from Mayo Reservoir, and 23 percent of the available excess from Lake Butner. These increased water use impacts are measurable and unavoidable. However, because they are well within the existing systems' capacities and available excess water, they are not considered as significant impacts.

Off-site water use projections for the SSC operations period are given by county in Table 7-6. As during construction, it is assumed that the additional demand for water in Durham County would be met by the City of Durham's water supply reservoirs, Lake Michie and the Little River Reservoir; the additional demand in Granville and Person Counties would

be met by Kerr Reservoir and Lake Issac Walton, respectively. The domestic water use projected for Durham County beginning in 1996 is 415 to 550 acre-ft/yr, or up to 3 percent of the combined excess of Lake Michie and Little River Reservoir. Granville County is expected to have a domestic water use increase of 80 to 105 acre-ft/yr, up to 3 percent of the currently available excess water from Kerr reservoir. Water use in Person County during the operations period is projected to be 35 to 45 acre-ft/yr, or up to 1 percent of the currently available excess (Sutherland 1988).

These increases from surface water sources constitute a measurable regional impact to the water supply systems of the area. However, these increases would probably not require any changes to the existing systems, unless the available excess water declines dramatically.



### 7.1.3.6 Tennessee

#### A. Surface Runoff

Hydrologic conditions at the proposed Tennessee SSC site are characterized by moderate to low relief, bedrock channels, and Karst features like underground channels, shallow sinkholes, etc. Rainfall-runoff relationships are important with a high annual precipitation rate, and high average flows per square mile of watershed. The site is well drained and contains a variety of vegetative land cover. Hydrologic and other features of the site and surrounding area are shown in Figure 7-10.

Total land disturbance anticipated at the Tennessee site is about 1,490 acres. About 480 acres would be disturbed during the construction of the SSC campus and injector facilities. These disturbed lands would be primarily concentrated in Armstrong Branch, a watershed of about 10-mi<sup>2</sup> tributary to the West Fork Stones River. The disturbance is, therefore, about 7.5 percent of the total watershed area. Rainfall in the area is abundant, about 51 inch/yr (U.S. Environmental Science Services Administration 1968), and the infrequent 50- and 100-yr, 6-hr storms are large, 4.7 inches and 5.0 inches, respectively (U.S. Weather Bureau 1961). This could cause a measurable increase in watershed runoff to Armstrong Branch. However, with the application of common stormwater management measures such as retention and detention basins, grass ditches instead of curb and gutter drainage, etc., this impact could be reduced to negligible levels.

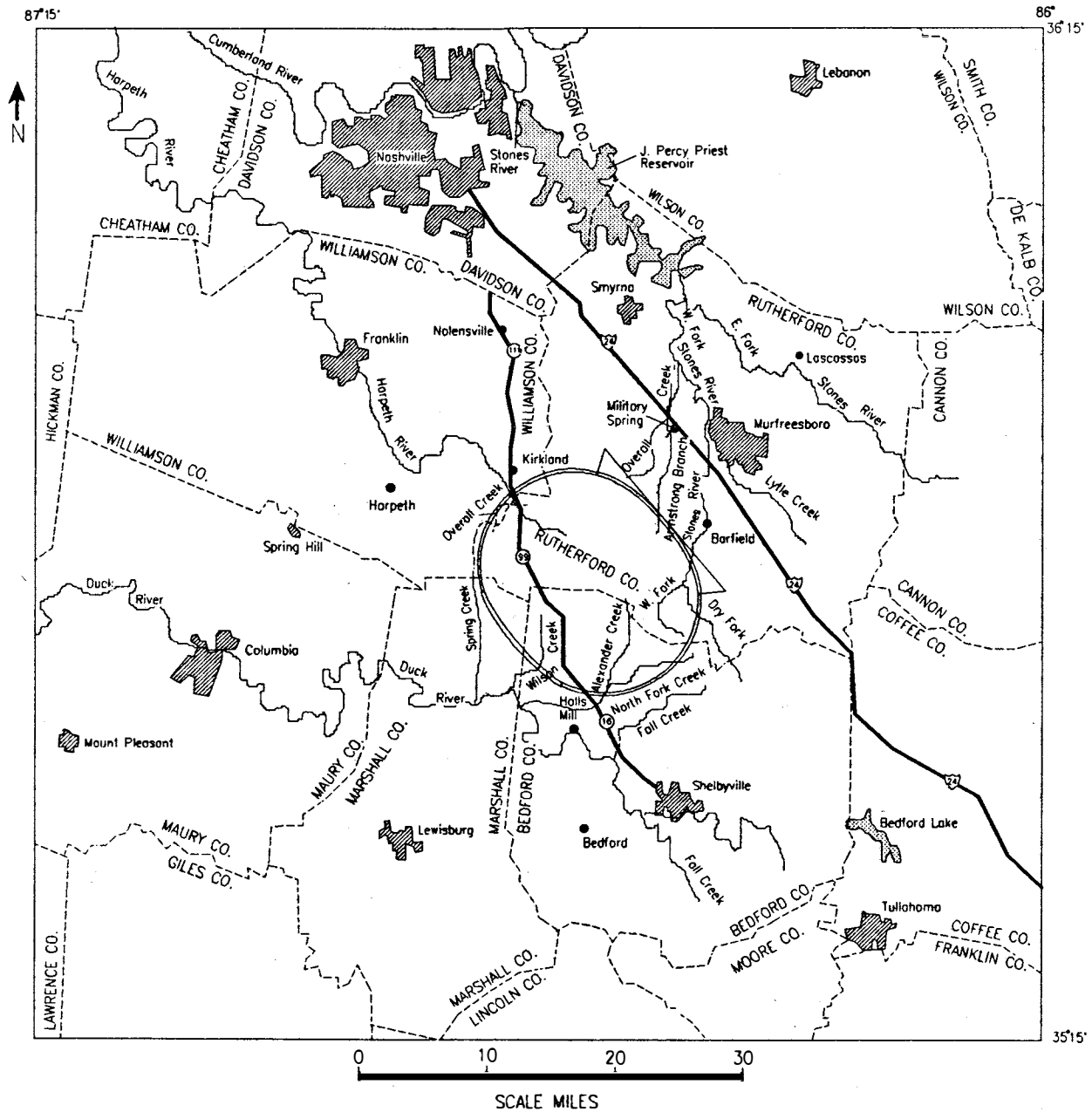
All other SSC facilities around the ring cause less than 5 acres of disturbance, and these should have no more than negligible impacts to surface runoff. New roads, railroads, and utility lines would also represent small areas of disturbance scattered about the region.

Regionally, the site disturbances are about 480 acres in the campus and injector area in Armstrong Branch, and about 1,490 acres for the entire SSC site. The watersheds under consideration would be much larger, i.e., Stones, Harpeth, and Duck rivers. The outlet of Armstrong Branch into the West Fork Stones River is at least 5 mi downstream from the campus area disturbance. The disturbed areas outside the campus area are widely scattered in small areas that are well upstream from the Duck and Harpeth rivers. Therefore, the regional impacts to surface runoff from the SSC project in Tennessee would be negligible.

#### B. Drainage Network

No drainage diversions or major drainage pattern modifications are planned. A moderate amount of cut-and-fill construction would be used on the injector and booster areas, but these would be almost on the watershed divide between Armstrong Branch and Overall Creek, both of which are tributary to the West Fork Stones River. Impacts to the drainage of this area would be negligible. Elsewhere around the site, and regionally, there would be no impacts to drainage patterns.

Figure 7-10  
HYDROLOGIC FEATURES - TENNESSEE SITE



### C. Floodplains

All four counties that would include parts of the SSC facility have FEMA maps available. However, only Williamson County is shown on the more detailed Flood Insurance Rate Maps. Bedford, Marshall, and Rutherford counties are only shown on Flood Hazard Boundary Maps. The lack of more detailed coverage indicates that there is a low potential for flood damage in the area. Indicative of this is the rural nature of the Tennessee site location, with scattered houses and few other buildings. During preconstruction analyses, geotechnical and other environmental studies would be performed to verify this assessment as part of final project design.

The available FEMA maps (FEMA 1977, 1981, 1984a, 1984b, 1988a, 1988b) mentioned above were used in preparing this floodplain assessment, to determine whether any of the proposed facilities may be in the 100-yr floodplain.

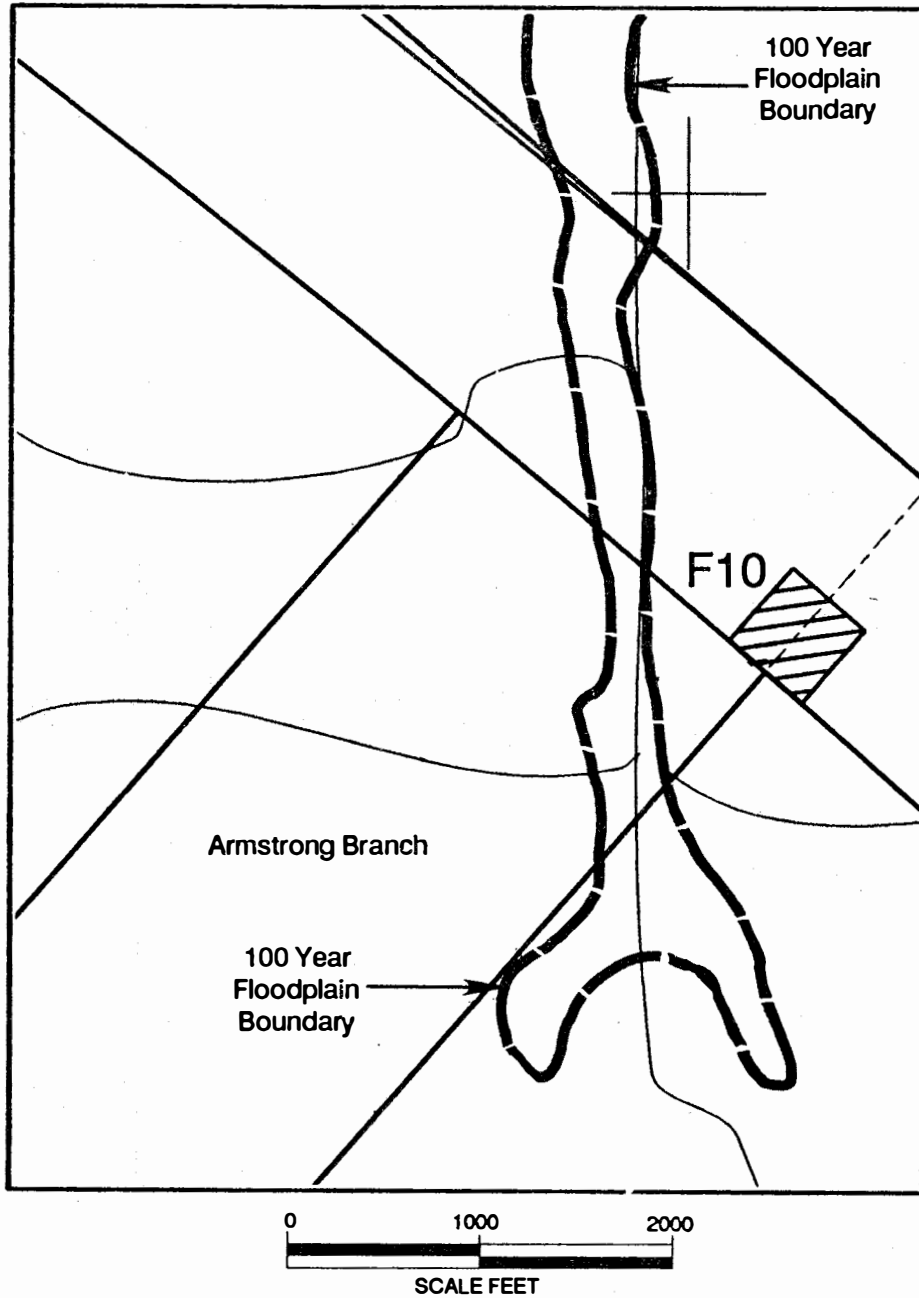
Temporary encroachment is likely on the Armstrong Branch from construction of the campus facilities or from the placement of buildings or other structures (Figure 7-10A). Service area F1 covers about 100 ft of a 300-ft-wide floodplain. Actual placement of surface structures in the campus area and in service areas remains relatively flexible at this time, and would not be determined until a preferred site is selected and site-specific designs prepared. Potential encroachment is based on the actual land areas and their location on or near floodplains. Other SSC facilities are located near floodplain areas and, depending upon final design, could also affect upstream flooding. These include: beam zone access areas J2 (Figure 7-10B) and J4 (Figure 7-10C), and service area F10 (Figure 7-10A).

In the campus area the new four-lane highway providing site access would cross Armstrong Branch, causing potential encroachment. Both this encroachment and the access road encroachment at E6 can be mitigated relatively easily because both streams are small (watershed areas <6 mi<sup>2</sup>) and their floodplains only 200 to 300 ft wide. With proper design of the bridge or culvert and possible channel improvements, this impact can be reduced to negligible levels at both places. Intermediate access area E6, depending upon final design, may encroach upon the Spring Creek floodplain by blocking up to 50 percent of the floodplain cross section at that point (Figure 7-10D). This encroachment can be mitigated because of the small watershed area upstream (less than 25 mi<sup>2</sup>), and with proper design this impact should be negligible.

Intermediate access area E1 is located wholly within the Stones River floodplain (Figure 7-10E). At its narrowest point adjacent to the facility, the floodplain is approximately 2,500 feet wide with an upstream watershed of less than 8 mi<sup>2</sup>; the 200-foot width of the facility is not likely to create upstream flooding impacts, and final design and facility placement and mitigation are likely to reduce the overall impact of the

Figure 7-10A

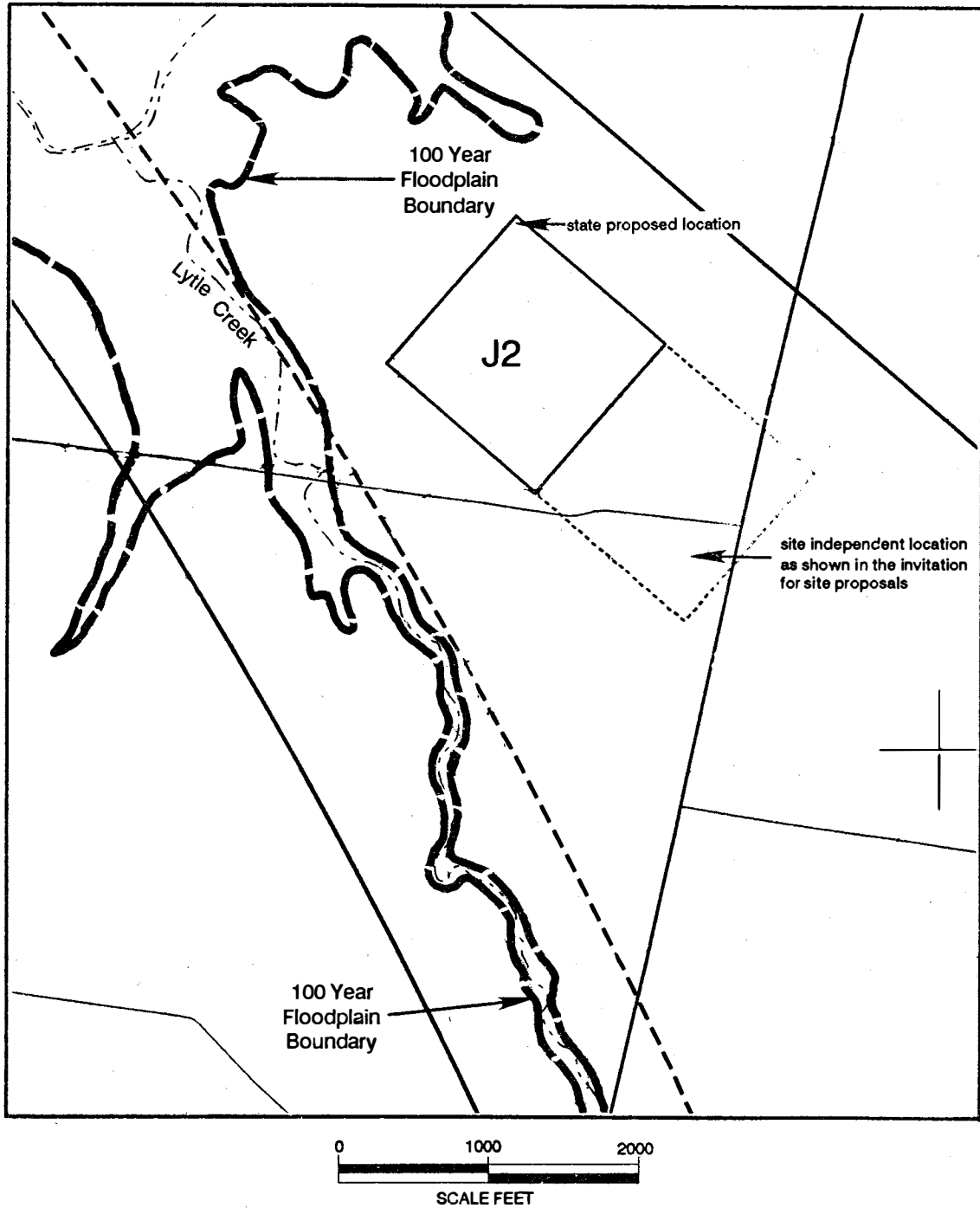
CAMPUS AREA ENCROACHMENT ON ARMSTRONG BRANCH FLOODPLAIN  
TENNESSEE SITE



Source: Federal Emergency Management Agency, 1984A.

Figure 7-10B

J2 PROXIMITY TO LYTLE CREEK FLOODPLAIN  
TENNESSEE SITE

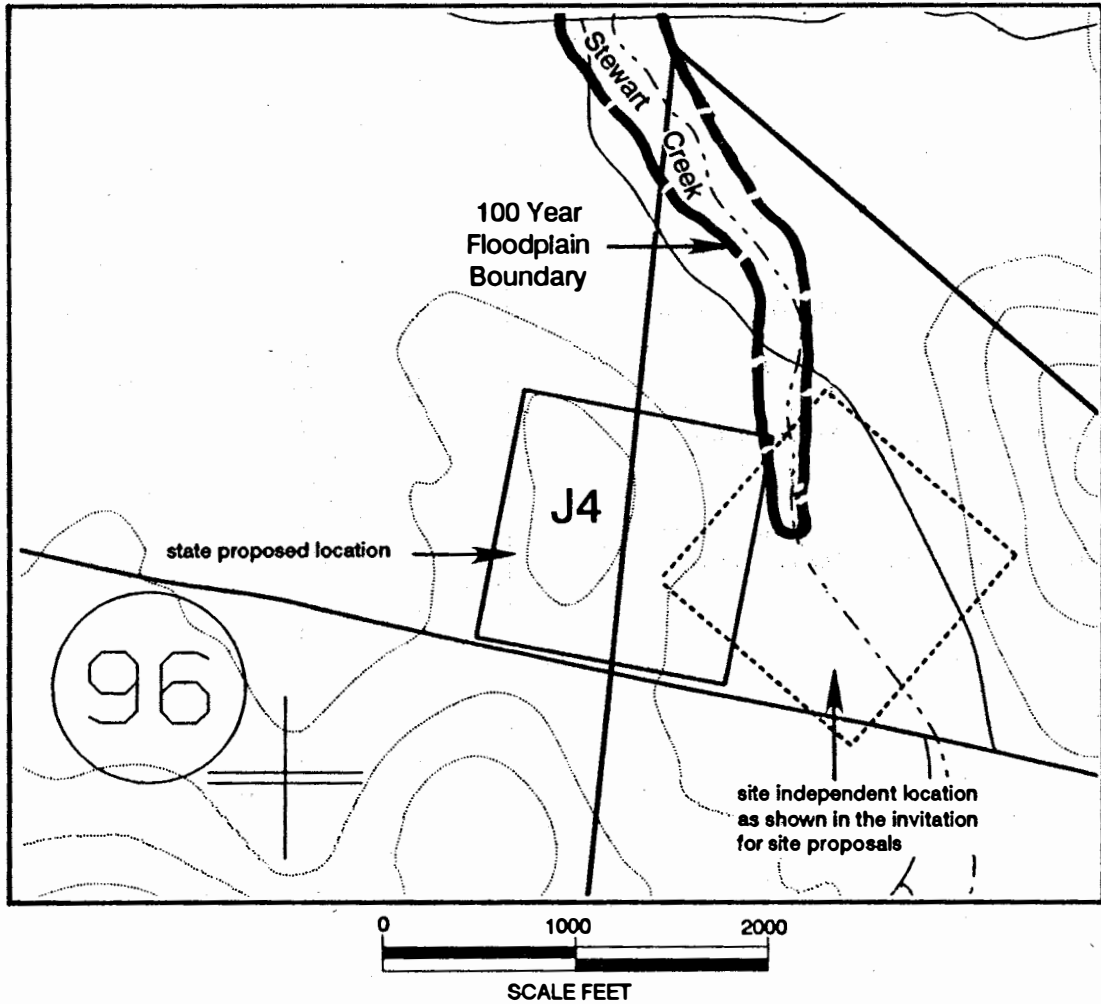


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Source: Federal Emergency Management Agency, 1984A.

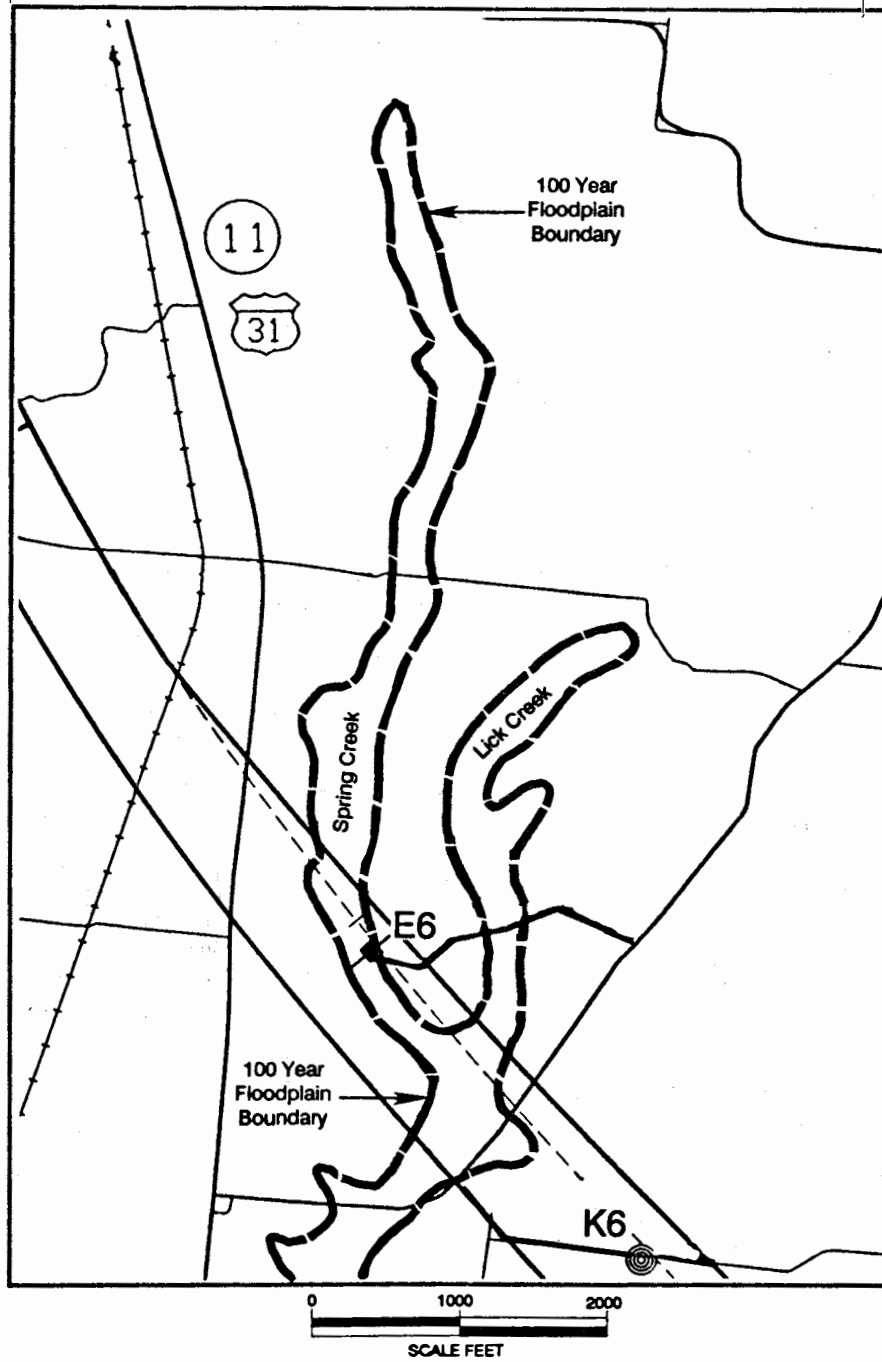
Figure 7-10C  
J4 ENCROACHMENT ON STEWART CREEK FLOODPLAIN  
TENNESSEE SITE



Source: Federal Emergency Management Agency, 1988A.

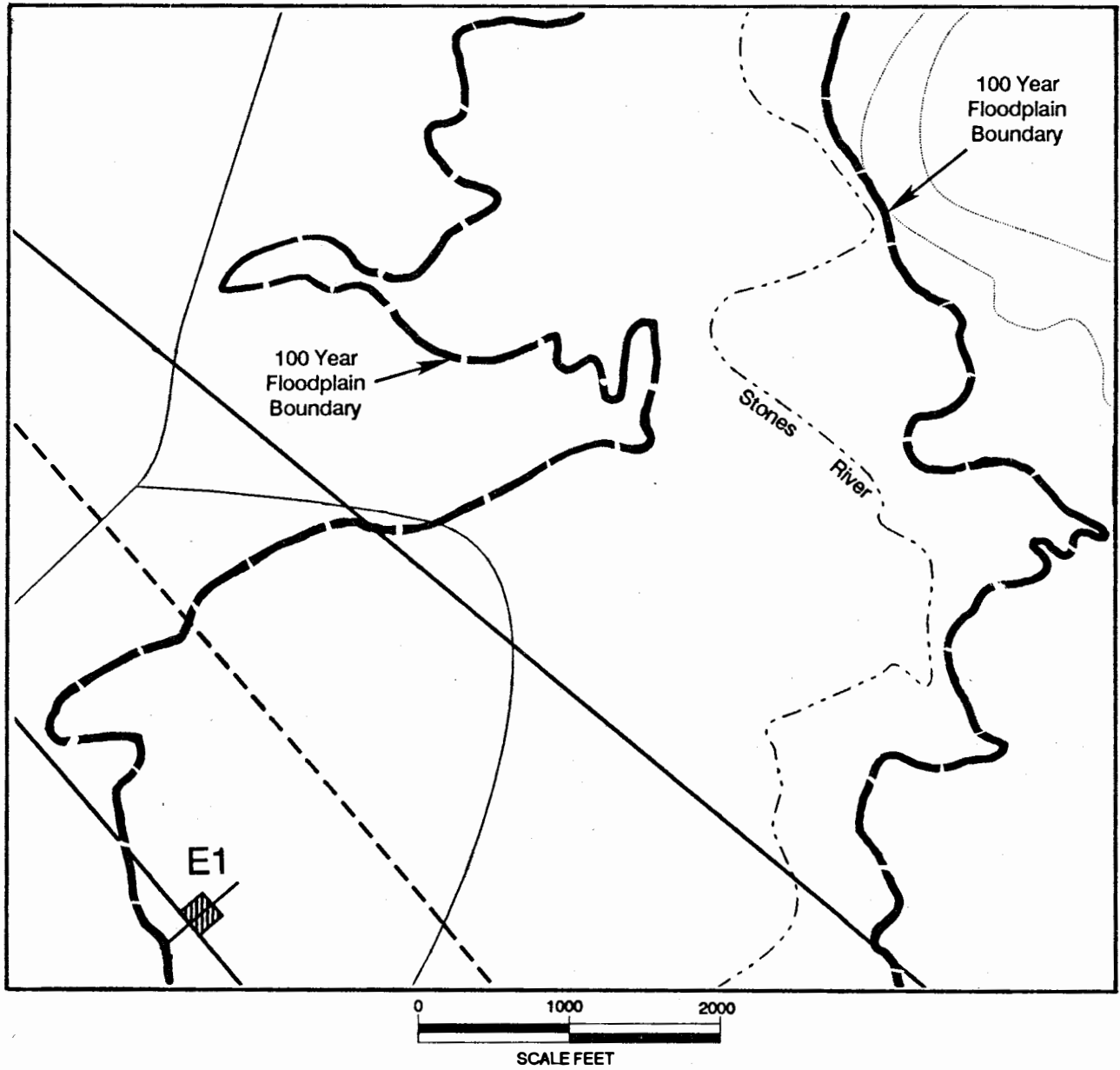
Figure 7-10D

E6 ENCROACHMENT ON SPRING CREEK FLOODPLAIN  
TENNESSEE SITE



Source: Federal Emergency Management Agency, 1988A.

Figure 7-10E  
E1 ENCROACHMENT ON STONES RIVER FLOODPLAIN  
TENNESSEE SITE



Source: Federal Emergency Management Agency, 1984A.



facility on floodplain encroachment. The F1 encroachment (Figure 7-10F) has both a new channel crossing and a possible facility placement in the floodplain. The channel is Christmas Creek, which has a small watershed of <math><5\text{ mi}^2</math>, so mitigating the crossing should not be difficult. Pending final design, the impact on the floodplain and local flooding, however, should be negligible.

#### D. Surface Erosion

Surface disturbance, climate, and hydrologic conditions would affect the potential for increased surface erosion from SSC construction. These factors were discussed in Section 7.1.3.6.A. Additional factors are the site topography and the proximity of disturbed areas to stream channels. The topography of the site is relatively shallow, at least around the ring where the surface disturbances would occur. However, a number of construction areas would be close to stream channels, allowing transport of sediment off site. The campus area and service area F10 are close to the Armstrong Branch channel. Service area F1 and access area E2 are next to Christmas Creek. Service area F4 and access area E5 are adjacent to channels in the North Fork Creek watershed. Finally, experimental hall K6 and access area E6 are very close to channels in the Spring Creek watershed (see Figure 7-10). These all have the potential to cause measurable surface erosion impacts to local channels.

Mitigation measures such as installation of sediment traps, sediment basins and surface cover, and construction staging could be used to minimize the amount of disturbed ground at any given time, thus helping to control surface erosion. These measures would help reduce off-site sediment transport, but it is likely that some measurable impacts would result on short stretches of channel (<math><1,000\text{ ft}</math>) immediately downstream from construction disturbances, primarily on Armstrong Branch. These would be short-term impacts not likely to be significant.

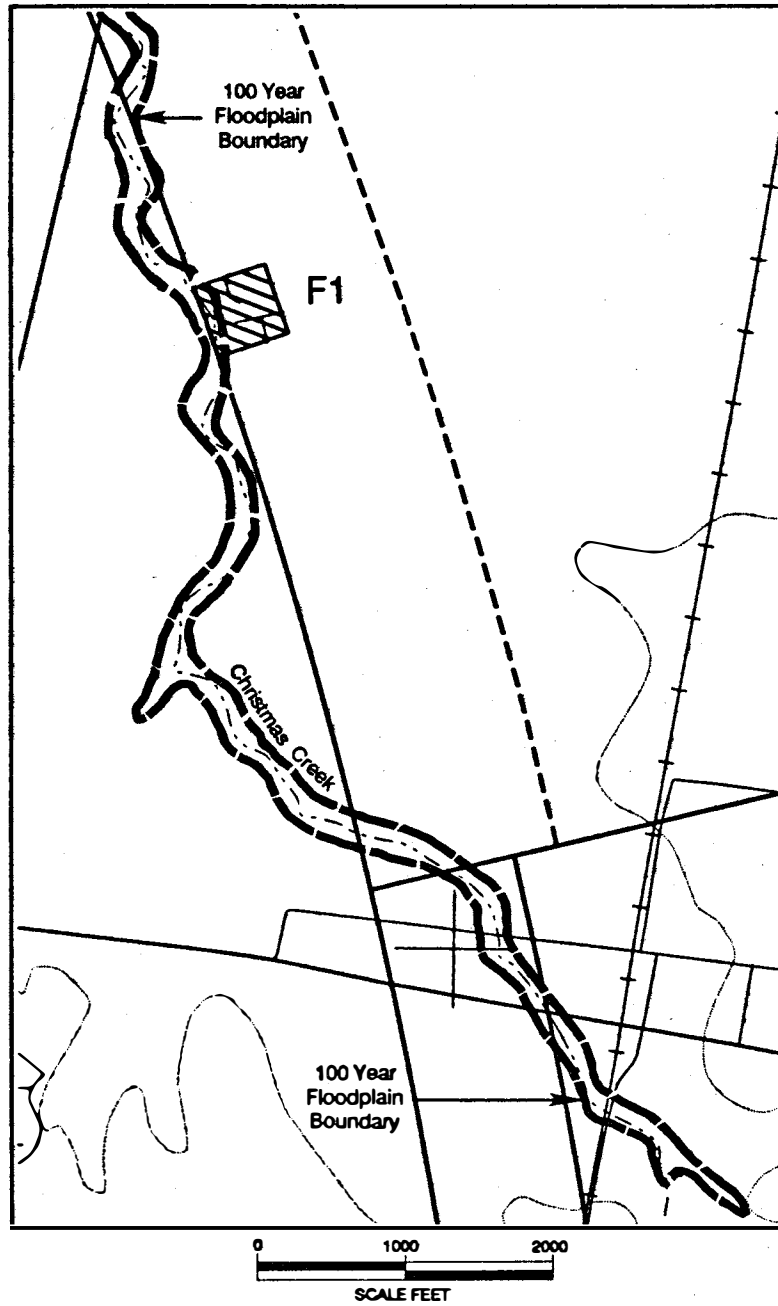
Regionally, there would be direct impacts from construction of new or improved roads, and from installation of new power lines, new water lines, a new sewer line, and new gas lines. These impacts would be narrow, linear disturbances that would cross many watersheds but not be concentrated in any one. Therefore, they are expected to have a negligible impact on surface erosion.

#### E. Channel Erosion

Runoff increases and channel material cohesiveness control the level of impacts from channel erosion. In Tennessee, runoff increases should be small, and the high percentage of bedrock in both channel beds and banks would restrict channel erosion impacts. The impacts should be negligible, even if mitigation is not used to control or reduce surface runoff increases.

Figure 7-10F

F1 ENCROACHMENT ON CHRISTMAS CREEK FLOODPLAIN  
TENNESSEE SITE



Source: Federal Emergency Management Agency, 1984A.

## F. Water Quality

### 1. Construction

Surface water quality impacts could be caused by direct project activities or by indirect activities related to the project. Specific results of these activities (results such as surface and channel erosion, pollutant washoff, tunnel dewatering, tunnel spoils piles, and increased wastewater treatment) could cause a deterioration of the natural surface water quality.

Surface erosion is expected to be highest in Armstrong Branch, although it may be short term. Other streams that may experience similar impacts are Christmas Creek tributary to the West Fork Stones River, and North Fork and Spring creeks, both tributary to the Duck River. Water quality impacts from additional sediment loads would be on the turbidity, TDS, nutrient, and other constituent levels. Such impacts would be short term, lasting only during construction.

Increases in pollutant washoff caused by SSC construction could be important. Development brings construction equipment, surface disturbance, potential for spills, increased emissions, and other sources of pollutants. This could be a problem in highly disturbed areas like the campus where more pollutants would concentrate. Mitigation using retention basins has proven most effective in trapping pollutants.

Dewatering of tunnel construction operations in Tennessee would occur at each tunnel access shaft with the water discharged into sedimentation ponds. Water in the ponds may then be discharged into the nearest stream system, used for construction, or reinjected into the groundwater; whatever method is used, care will be taken to control the method and rate of discharge so that it does not unacceptably impact the sensitive hydrology and fauna of the karst and cave systems. Rejected water should not impact surface water quality. Water used for construction is not assessed here because it was considered under construction activity impacts (surface erosion) and pollutant washoff impacts to water quality. Water discharged to natural stream systems may cause a measurable impact if the sedimentation ponds are not effective. This would impact only short stream reaches, would not be a significant impact, and would be short term, during construction only.

Tunnel spoils disposal options would include two possibilities for reuse (resale for road construction and for limestone) and one for disposal (on-site disposal). Proposed disposition of spoils is presented in Section 10.2.3.6 of Appendix 10. No potentially harmful leachate has been identified in the rocks to be tunneled, so leachate production should not be a problem. The reuse alternatives involve potential impacts from erosion and washoff of sediment and/or leachate. Such off-site transport of sediment can have impacts on water quality. Stockpiling locations cannot be determined until a site-specific design is prepared that includes staging, access, and other aspects of construction.

The disposal option involves using 35 disposal sites spread around the ring area. Approximate locations of these proposed disposal sites are given in Appendix 10, Section 10.2.3.6.A. These sites would have significant potential for erosion and transport of sediment off site. Four factors affect this potential: topography, surface area of spoils, amount and type of rainfall, and proximity to streams. Ten of the disposal sites have surface slopes in excess of 8 percent in the adjacent topography. The sites would have a combined surface area of about 250 acres of spoils. Rainfall in the area averages 50 inch/yr and can occur in high-intensity thunderstorm events. All of the proposed locations are in hollows or valley heads, i.e., in natural sediment transport pathways. While only six of the disposal sites fall within 1,000 ft of a perennial stream, two of these are on perennial streams and most of the others are in intermittent stream courses. The potential for the transport of sediment from these sites is large. Mitigation using sediment basins would help control sediment, but the impacts on surface water could still be measurable and significant.

Increases to the wastewater generated in the region during construction would result from in-migration induced by the project. Appendix 14, Section 14.1.3.6.A projects that largest population increases through the peak of construction (1992) would occur in Davidson County (about 5,100 people), Rutherford County (about 4,500), and Williamson County (about 1,100). The combined available capacity for wastewater treatment in each of these counties currently is 17.0 million gal/d in, 8.4 million gal/d, and 1.1 million gal/d, respectively (Tennessee Water Pollution Control 1988). Therefore, the additional wastewater treatment needed (assuming 100 gal/d/capita wastewater production) in each of these counties is only 3 percent, 5 percent, and 10 percent, respectively, of the existing capacity. This is a small amount of the capacities already permitted. Because these plants operate under the regulation of NPDES permits, additional treatment amounts within existing capacities should have a negligible impact on surface water quality in the streams to which they discharge.

## 2. Operations

The only area of concern for impacts to surface water quality associated with SSC operations is the discharge of wastewater and/or cooling tower blowdown. Cooling water from the experimental areas and service areas would be handled by using vacuum-compression brine concentrator units or side-stream softening. Neither of these should have an impact on surface water quality, since effluent would not be discharged directly to the natural stream system. Wastewater and cooling tower blowdown from the campus area would be transported to the Murfreesboro treatment plant. This would be about 150,000 gal/d of sewage and 100,000 to 150,000 gal/d of cooling water, which is well within the available capacity of this plant (about 5 million gal/d). Additional off-site increases in wastewater for all of Rutherford County would be about 420,000 gal/d. This also is well within the current available capacity for Rutherford County

(Tennessee Water Pollution Control 1988). Because the increase would be well within existing, permitted capacities, there would be a negligible impact on surface water quality. For sewage treatment near the far cluster area, permanent packaged tertiary treatment plants will be installed. At remote service areas sewage will be disposed of by septic tanks and leach fields.

## G. Water Use Increase

### 1. Construction

The water supply proposed for the SSC facility in Tennessee is primarily surface water. General projected water needs during the construction period are given in Table 7-1. Estimated off-site domestic water use for the construction period is given in Table 7-7.

The primary source of construction water for the campus and injector complex is the Consolidated Utility District of Rutherford County. The District uses Stones River water impounded in the J. Percy Priest Reservoir, with a design capacity of 5,320 acre-ft/yr, and a current available excess capacity of about 2,070 acre-ft/yr. The entire expected construction demand for the peak year 1992 would be 88 acre-ft, less than 5 percent of the available excess. It is likely that small amounts of the construction water supply would come from several other water supply systems in the area, but none approaching a value as high as 5 percent of their existing excess.

Off-site domestic water use also would peak in 1992, as indicated in Table 7-7. The largest increase in water use is expected in Davidson County, and it is assumed the Nashville Water Supply System would provide this water. The currently available excess water in the Nashville system is over 100,000 acre-ft/yr. The expected peak demand is less than 1 percent of this. Other water systems affected by increased off-site domestic water use during construction would be Bedford County Utility District, Marshall County Utility District, and two Rutherford County systems (Consolidated and Murfreesboro). It is assumed for this assessment that each would supply the entire expected increase in water use for that county, except in Rutherford County where Consolidated and Murfreesboro would each supply half of the increased demand. Using the peak water use values for 1992 as a percentage of the currently available excess, Bedford County would require 21 percent, Marshall County 2 percent, Consolidated 9 percent, and Murfreesboro 6 percent. The Consolidated Utility District would have a total water use increase of slightly more than 13 percent when construction use and domestic use are combined. All of these increases represent measurable impacts, with the exception of the increases for Marshall County Utility District and the Nashville Water Supply System. They are essentially unmitigable, and would be significant and short term.

Table 7-7

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
DURING SSC CONSTRUCTION AND OPERATIONS  
IN TENNESSEE<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)					Water Use During Operations (acre-ft/yr)		
	1989	1990	1991	1992	1993	1994	1995	
Rutherford County	70	260	475	495	440	485	435	355 - 465
Marshall County	5	10	15	15	15	15	15	10 - 15
Bedford County	5	20	40	40	35	40	35	25 - 35
Davidson County	100	305	560	570	490	520	440	365 - 485
Other Nearby Counties <sup>2</sup>	<u>90</u>	<u>275</u>	<u>505</u>	<u>510</u>	<u>435</u>	<u>455</u>	<u>380</u>	<u>315 - 420</u>
<b>TOTAL</b>	<b>270</b>	<b>870</b>	<b>1,595</b>	<b>1,630</b>	<b>1,415</b>	<b>1,515</b>	<b>1,305</b>	<b>1,070 - 1,420</b>

1. Estimated domestic water use is based on population projections multiplied by a factor of 100 gal/d/capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Tennessee. The estimates do not include water delivered for industrial and commercial use.
2. Includes estimates for Cannon, Cheatham, Coffee, DeKalb, Franklin, Giles, Grundy, Lincoln, Marion, Maury, Moore, Smith, Summer, Trousdale, Warren, Williamson, and Wilson counties.

## 2. Operations

Surface water would also be the primary source of water for both the operations of the SSC facility, and the off-site domestic uses. Table 7-1 gives the expected water needs for operations by use and area. It is expected that the facility water supply would be broken down as follows. The Consolidated Utility District and Murfreesboro Water System would supply the campus, injector, F1, F2, F9, F10, K1, and K2 areas, for a total of 1,235 acre-ft/yr. The Marshall County Utility District would supply the F5 and F6 service areas and experimental halls K5 and K6, for a total of 220 acre-ft/yr. Service areas F3 and F4 would be supplied by the Bedford County Utility District with 160 acre-ft/yr, and the remaining service areas F7 and F8 would be supplied by groundwater.

Additional water demand would come from off-site domestic water use. Table 7-7 gives the estimated domestic water use for the surrounding counties during operations. It is assumed that the Consolidated Utility District, Murfreesboro water system, and the Smyrna system would supply all Rutherford County needs; the Bedford Utility District and Shelbyville System would supply all of the Bedford County increase; Marshall County utility districts would supply all of its demand; and the Nashville system would supply all demand in Davidson County.

The projected off-site demand for surface water in Rutherford County during operations would be 355 to 465 acre-ft/yr. For Davidson County, the projected demand would be 365 to 485 acre-ft/yr, and for Bedford and Marshall counties the demand would be 25 to 35 acre-ft/yr and 10 to 15 acre-ft/yr, respectively. Adding the campus area operations water use to the off-site demand, the total SSC-related increase in water use would be almost 2,300 acre-ft/yr in Rutherford County, or about 22 percent of the available excess surface water. For Marshall and Bedford counties, the combined demand would be about 215 acre-ft/yr and 115 acre-ft/yr, respectively, or a use of about 13 percent and 3 percent of their available excess capacities. Only off-site increases in water use are expected in Davidson County, and these should be less than 1 percent of the available capacity.

This evaluation assumes that the water use would be distributed throughout each of these counties, in some cases over several water supply systems. If so, the impact of the increased water use caused by the SSC project should be negligible. However, if some of this demand is concentrated on individual systems, some system expansions could be hastened, because of the increased demand. The Murfreesboro Consolidated Utility District and Bedford County Utility District water supply systems could feel this pressure.

### 7.1.3.7 Texas

#### A. Surface Runoff

With moderate temperatures, medium annual rainfall, and moderate humidity, the climate at the site is characterized as continental and moderate. The site and regional areas associated with hydrologic impacts are shown in Figure 7-11.

Total land disturbance anticipated for the Texas site is about 1,690 acres. The campus and injector area construction would disturb about 480 acres. Most of this disturbed area falls in the watersheds of two parallel tributaries to Chambers Creek, which have a combined drainage area of less than 10 mi<sup>2</sup>. This represents a disturbed area of 7.5 percent of the two watersheds, which could be an impact to the surface runoff of these tributaries. Mitigation measures such as detention and retention basins could help reduce this runoff and control flood potential.

The average annual precipitation in the general region of the site in Texas is about 32 inches (U.S. Environmental Science Services Administration 1968). Thunderstorms occur on an average of 51 times per year, primarily from April through August. The 6-hr precipitation events with 10-, 50- and 100-yr return periods are 4.6 inches, 6.2 inches, and 7.6 inches, respectively (U.S. Weather Bureau 1961). Frequent thunderstorms and large, infrequent rainfalls make potential for runoff high. This would exacerbate any changes in surface runoff characteristics, and increase the size and cost of mitigation structures. However, the rural nature of the area makes the impacts less significant.

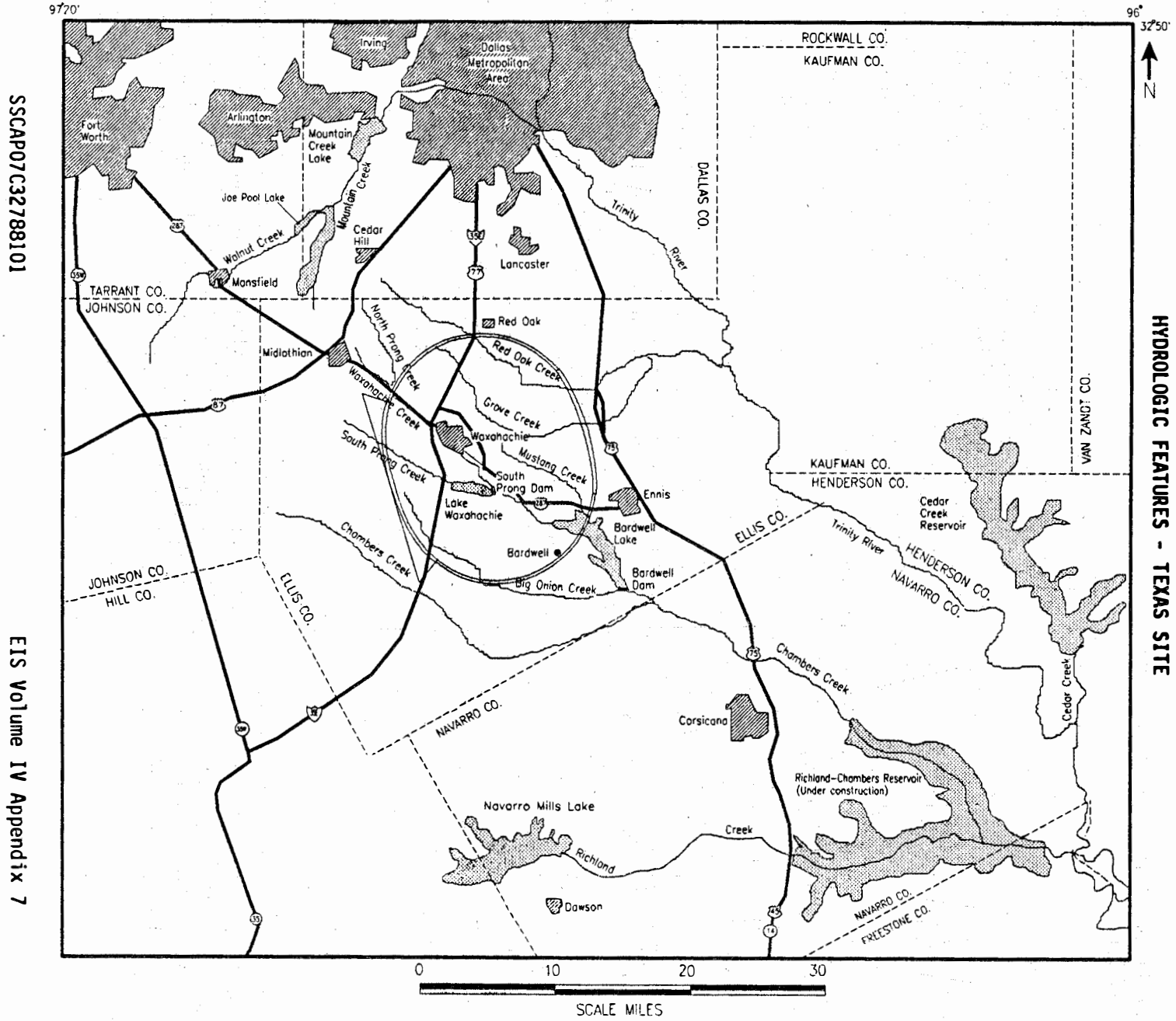
The other major project facilities are dispersed around the ring. Their disturbed area is small (<20 acres), and their impacts to surface runoff at both the site and regional levels would be negligible.

#### B. Drainage Network

The campus area includes the headwaters of three small streams, setting up the possibility of minor intrabasin or interbasin flow diversions. A need for this type of flow diversion could only be determined during site planning and design, thus it is not presently under consideration. Because these drainage areas are so small, such diversions could have a short-term, minor impact. Levees and surface water diversion channels would be employed to protect the open excavations for injector/booster tunnel construction. This can be accomplished in short stages, requiring only minor diversions that would not change the drainage areas. By using construction staging as a mitigation, the residual impacts should be negligible.

External beam access areas J2, J3, J4, and J6 (if constructed initially) may require drainage diversions. These would involve short channel diversions if construction of surface facilities dictates such a diversion. This would not require any change in drainage areas and impacts would be





negligible. No other direct impacts from the SSC facility have been identified at the Texas site. No direct or indirect impacts to drainage networks on the regional level are expected.

### C. Floodplain

The single county containing the proposed Texas SSC facility is included in the national flood insurance program. Ellis County is shown on the Flood Insurance Rate Maps, including the entire ring and surface facilities. In spite of the generally rural nature of the area, it has been included in the full flood insurance program, by this mapping level. These maps have been used in preparing this floodplain assessment to determine whether any of the proposed facilities may be in the 100-yr floodplain. During preconstruction analysis, geotechnical and other environmental studies would be performed to verify this assessment as part of final project design.

DOE has initiated informal consultation with the Fort Worth District Corps of Engineers concerning floodplain issues (Schaufelberger 1988).

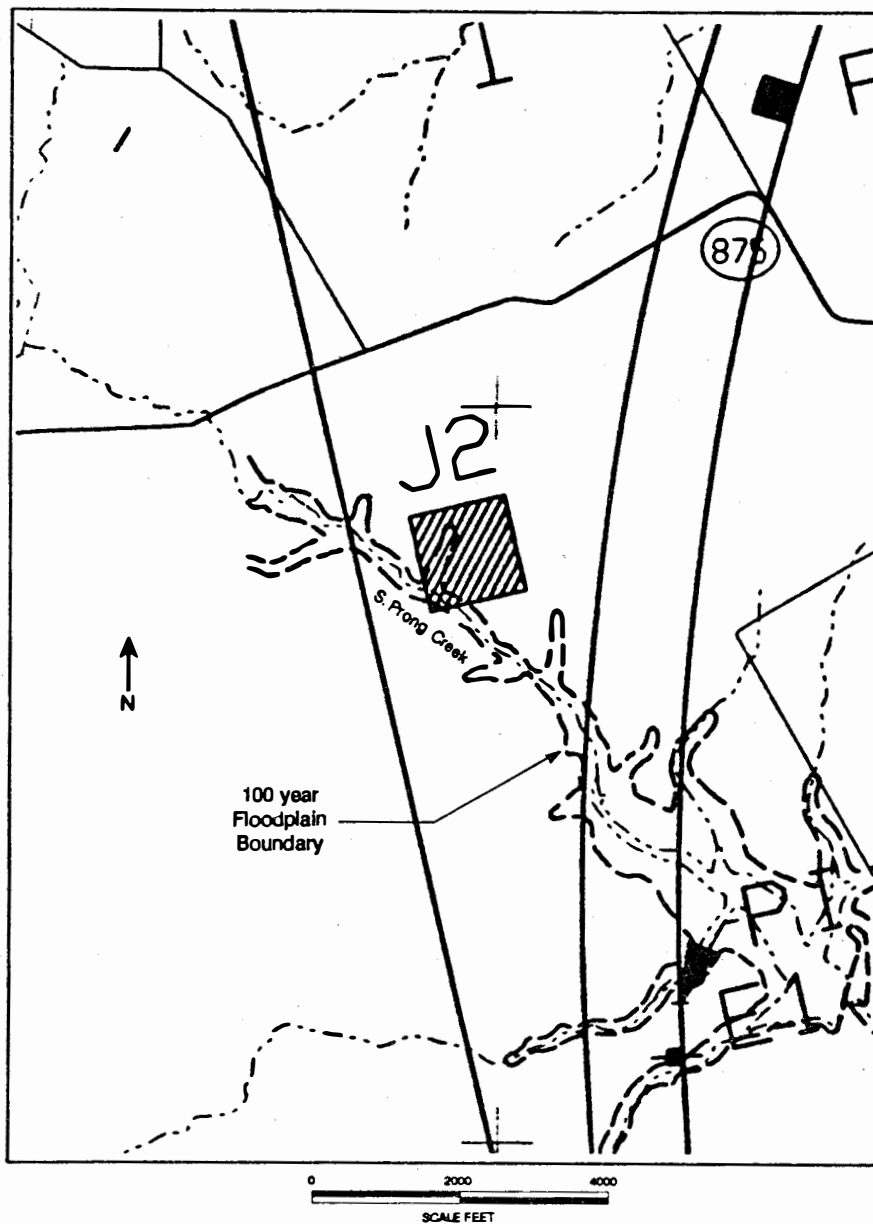
Project facilities that would be located partially or entirely within existing floodplains include: J2 in South Prong Creek, J3 in Baker Branch, J4 in Chambers Creek and J6 in a tributary to Chambers Creek. Two intermediate access areas, E1 and E9, are located in floodplains: E1 in South Prong Creek, and E9 in the Mill Branch of Chambers Creek. Actual surface structure locations within the facility boundaries, and in some cases the boundaries themselves, remain relatively flexible at this time. The final locations of facilities (which would not be determined until site-specific design drawings are prepared for the selected site), if possible, would be sited to avoid floodplain encroachment. If required, mitigation measures such as the construction of levees would be evaluated during final site design.

External beam access area J2 is located with its southeast corner crossing South Prong Creek. The floodplain at this location is approximately 250 to 300 ft wide and the encroachment would completely span this distance (Figure 7-12). This impact could be mitigated through design layout options or channel diversion.

External beam access area J3 is situated on Baker Branch, a tributary to Chambers Creek (Figure 7-13). As currently located, it completely covers the floodplain, which is 200 to 300 ft wide in this location. Again, some latitude for design layout options and potential channel diversion or leveeing could help mitigate flooding problems.

External beam access area J4 is presently located in the floodplain of Chambers Creek, a watershed of 107 mi<sup>2</sup>. The floodplain is about 500 to 750 ft wide at this location, and the facility would cross the entire width of this floodplain (Figure 7-14). Because this is a larger

Figure 7-12  
J2 ENCROACHMENT ON SOUTH PRONG CREEK FLOODPLAIN  
TEXAS SITE



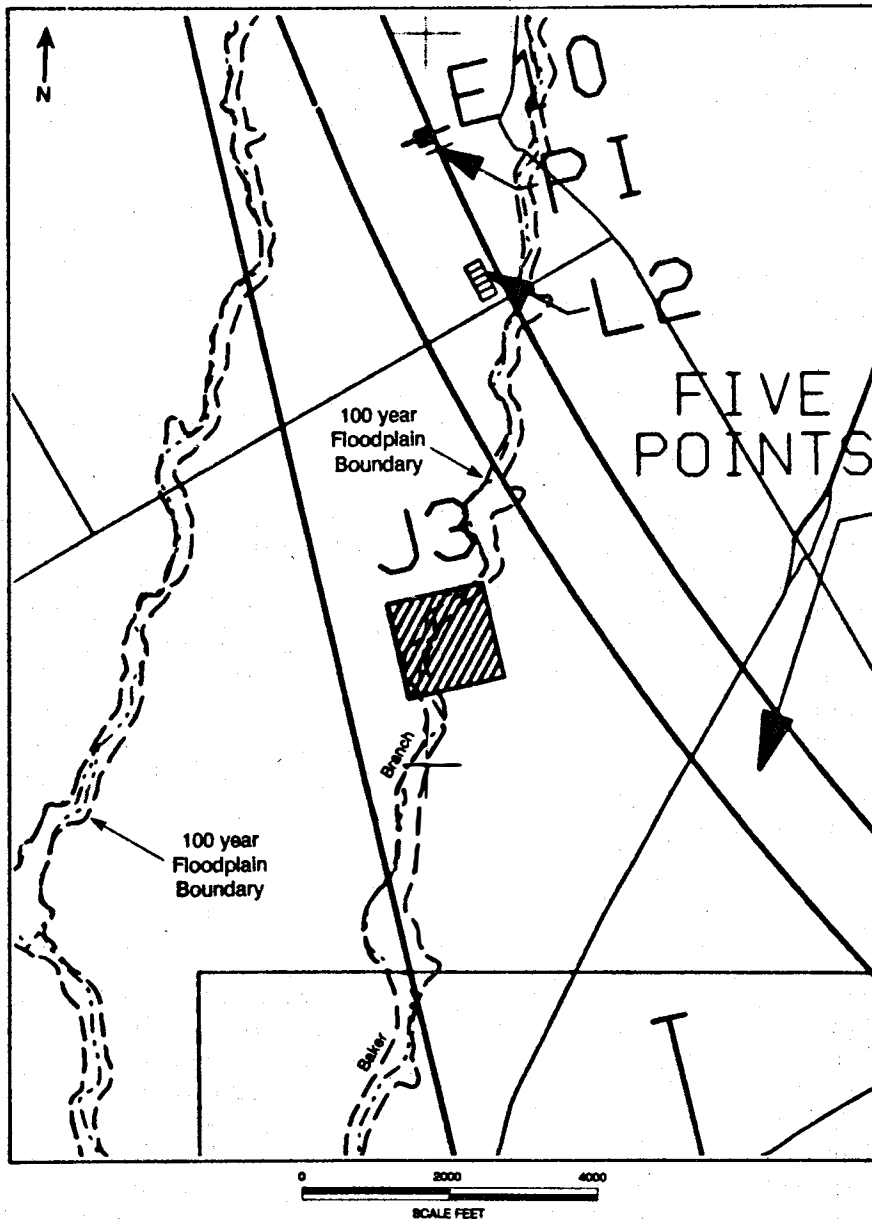
Source: Federal Emergency Management Agency, 1987.

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Figure 7-13

J3 ENCROACHMENT ON BAKER BRANCH FLOODPLAIN  
TEXAS SITE

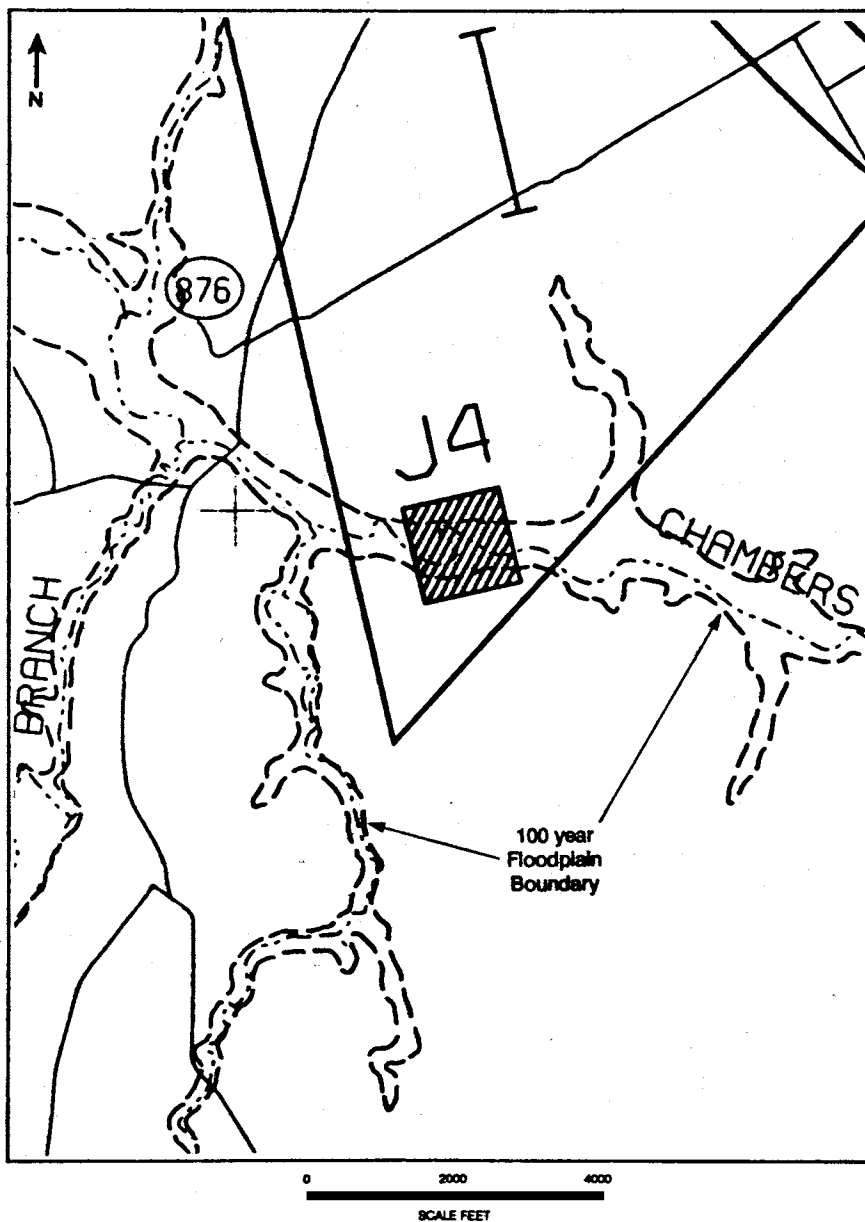


Source: Federal Emergency Management Agency, 1987.

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Figure 7-14  
J4 ENCROACHMENT ON CHAMBERS CREEK FLOODPLAIN  
TEXAS SITE



Source: Federal Emergency Management Agency, 1987.

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stream, providing mitigation could be more difficult. Therefore, the impact on flooding in Chambers Creek from this encroachment could be significant over the long term.

External beam access area J6 is presently located in the floodplain of an unnamed tributary to Chambers Creek. The southeast corner of this facility completely crosses the floodplain (Figure 7-15). However, this is the upstream limit of the mapped floodplain on a watershed less than 3 mi<sup>2</sup> in area. For this reason, mitigation through design layout and berms or levees should reduce the impacts from encroachment to negligible levels.

Intermediate access area E1 is located in a tributary of South Prong Creek. The encroachment should not create flooding impacts as the upstream watershed is very small (less than 0.1 mi<sup>2</sup>) and the encroachment only covers a small portion of the floodplain (Figure 7-15A). Intermediate access area E9 is located in Mill Branch of Chambers Creek. As the encroachment is small and the upstream watershed is less than 0.8 mi<sup>2</sup>, flooding impacts are expected to be negligible (Figure 7-15B). In addition, final placement and mitigation is expected to further minimize any flooding impacts.

Two access roads, one to service area F3 and the other to access area E8, would cross the stream channels of Red Oak Creek (about 1,000 ft wide) and Big Onion Creek (about 1,500 ft wide). Mitigation of these encroachments would require careful design of the bridge or culvert used and the amount of roadway embankment. Some level of impact to the flooding of these channels upstream of their crossings may be deemed acceptable and prudent, if the area is relatively rural and the impact otherwise not significant.

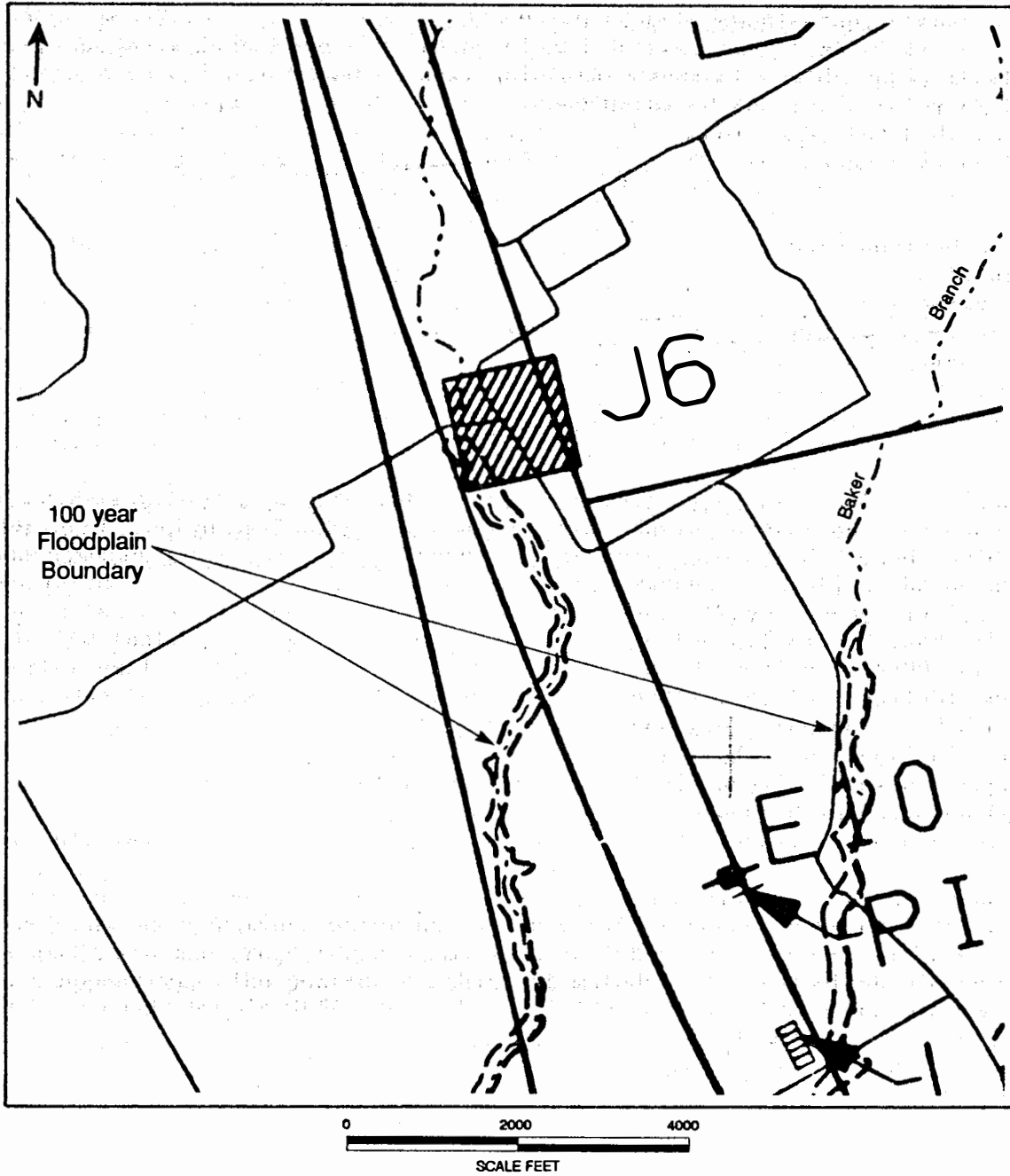
#### D. Surface Erosion

Construction of the SSC would cause surface disturbances by clearing vegetation, grading, excavating, and general heavy equipment movement. This would involve surface facility construction, and excavation and fill methods for the injector/booster tunnel construction. Off-site disturbances would include new access road construction, power line extensions, new water lines, new sewers, and new gas lines. A discussion of these features as they are proposed for the Texas site is given in Section 1.2.7 of Appendix 1.

Most of the disturbance would be in the Chambers Creek watershed. In addition to most of the campus area, the injector/booster construction disturbance, experimental halls K1 and K2, service areas F9 and F10, and access area E10 are also in this watershed. This is about 500 acres (0.78 mi<sup>2</sup>) of disturbed land, or less than 1 percent of the watershed. This would be a short-term impact on the tributaries for short reaches (<1,000 ft) immediately downstream from the injector excavation. Even with mitigation from sediment traps and basins, some impacts would remain. Downstream on Chambers Creek proper the expected impacts from surface erosion would be negligible.

Figure 7-15

J6 ENCROACHMENT ON UNNAMED TRIBUTARY TO CHAMBERS CREEK FLOODPLAIN  
TEXAS SITE

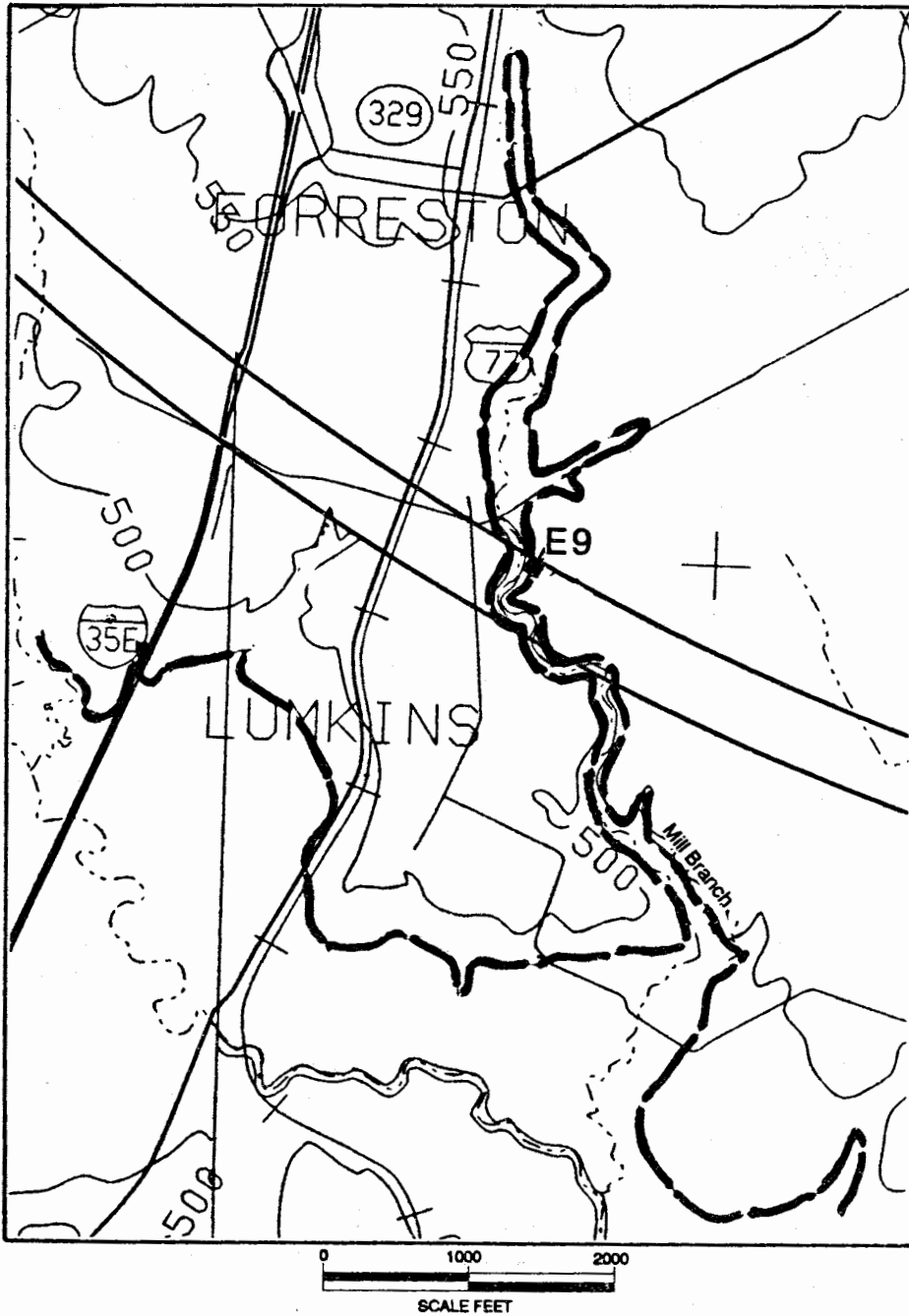


Source: Federal Emergency Management Agency, 1987.

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Figure 7-15A  
E9 ENCROACHMENT ON SOUTH PRONG CREEK FLOODPLAIN  
TEXAS SITE



Source: Federal Emergency Management Agency, 1987.

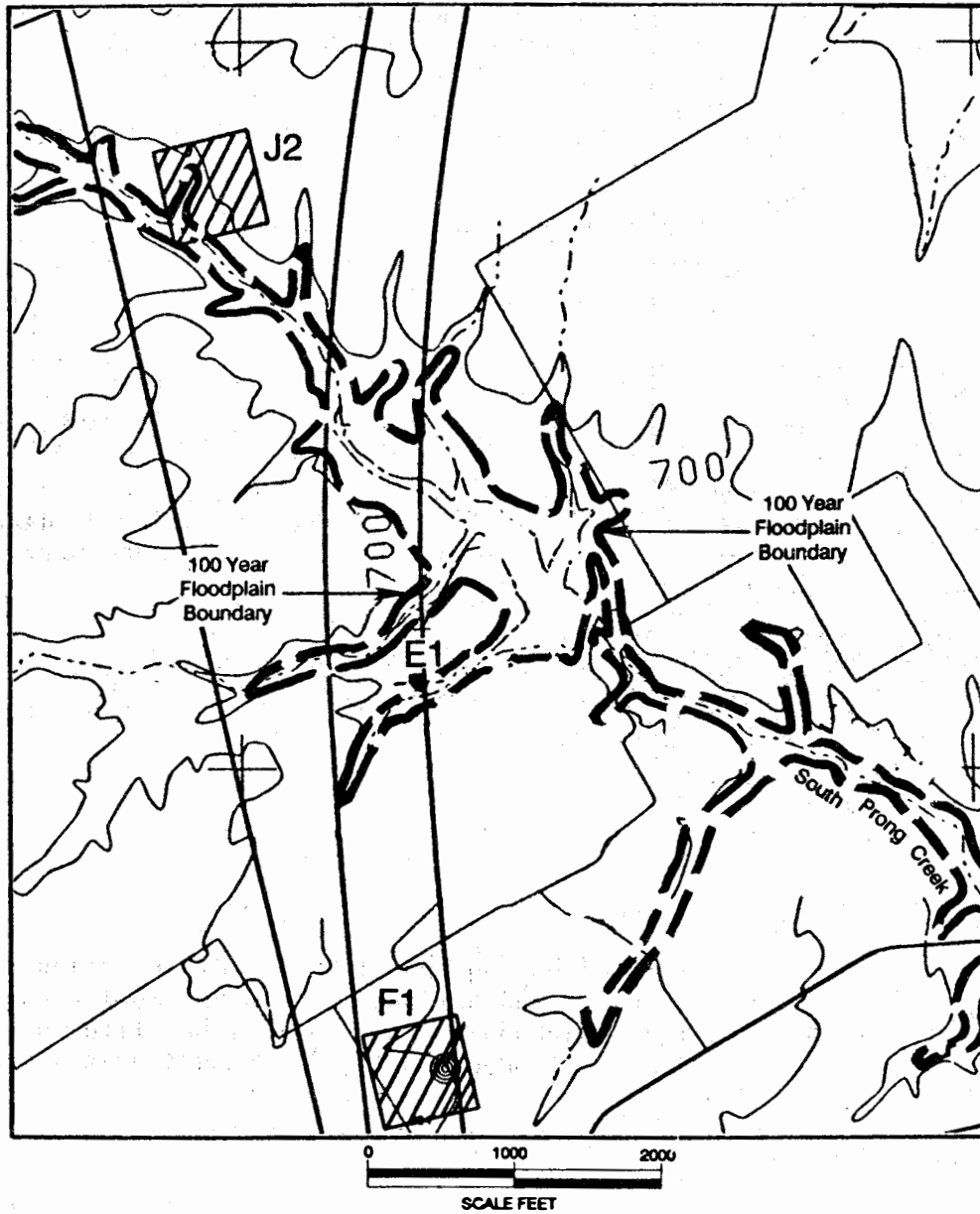
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Figure 7-15B

**E1 ENCROACHMENT ON MILL BRANCH OF THE CHAMBERS CREEK FLOODPLAIN  
TEXAS SITE**



Source: Federal Emergency Management Agency, 1987.

SSCAP07C32788109

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There are four options for disposition of spoils in the Texas site region, as described in Section 10.2.3.7 of Appendix 10. Two of these options involve reuse of the spoils (for construction materials or in cement production), and the other two are disposal options (in quarries or landfills). The reuse options present erosion impacts primarily from the potential for erosion from stockpiled spoils, and washing offsite into the drainage network. Because stockpiling would only be for short durations, standard containment procedures should mitigate any potential erosion of spoils. Disposal of the spoils in quarries or landfills should not present an erosion problem, since drainage controls would already be employed or not necessary (because of interior drainage). Therefore, a negligible impact is expected on surface erosion from the two disposal options.

#### E. Channel Erosion

Channel erosion results from increasing runoff through changes to the land surface characteristics in the watershed or altering drainage through diversions. Both of these impacts have been evaluated in Section A., Surface Runoff, and Section B., Drainage Network, above. These impacts are expected to be negligible. The longer-term changes to the watersheds draining the site are most important in causing runoff changes that might impact channels. Only the campus area would have a significant amount of impervious surfaces present for the long term. It would be something less than the total 200 acres for the campus area, which was assumed to be disturbed during construction. However, it is in the headwaters of two separate basins and its impact lessened. With mitigation measures discussed earlier the impact on runoff, and hence on stream channels, should be negligible.

Other disturbed areas around the ring would be much smaller (<20 acres) and therefore less likely to impact stream channels.

#### F. Water Quality

##### 1. Construction

Surface water quality impacts could be caused by direct project activities or by indirect activities related to the SSC. Specific results of these activities (such as surface and channel erosion, pollutant washoff, tunnel dewatering, tunnel spoils, and increased wastewater treatment) could cause a deterioration of the natural surface water quality.

Erosion would be highest in the Chambers Creek watershed, and more specifically, on Baker Branch. Other streams that may experience similar erosion (although on a much smaller level) are South Prong Creek, Greathouse Branch, Red Oak Creek, and Waxahachie Creek. Erosion in the campus area could cause an impact on the water quality of Baker Branch. However, this would only be a short-term impact, and probably not

significant. Baker Branch is an intermittent stream, and as indicated in Section 5.2.7.1.B of Appendix 5, the ambient water quality downstream in Chambers Creek did not meet the standards for its classification.

Increases in pollutant washoff caused by SSC could occur during construction and operations. Development brings construction equipment, surface disturbance, spills, increased emissions, and more impermeable surfaces to accumulate pollutants for easy wash-off. This is most likely to be a problem in the areas of highest disturbance like the campus, where more pollutants would concentrate. Mitigation using retention basins has proven most effective in trapping pollutants. However, even with retention basins some materials pass through and this may cause a measurable impact with long-term implications. This may or may not be significant based on the ambient water quality in Chambers Creek, and by implication, Baker Branch.

Dewatering is not expected to be necessary, as discussed in Section 10.2.3.7 of Appendix 10. Therefore no impacts are expected from discharge of water from the tunnel to natural channels, because no water is expected.

Short-term impacts to surface erosion are expected from stockpiling of spoils, if such stockpiling is necessary. This could also be a short-term impact to the water quality of streams near the stockpiling areas. This impact can be reduced to negligible levels by use of sediment traps (retention ponds, silt fences) around temporary stockpiles. Tunnel spoils disposal options for the site include possibilities for reuse (cement production, construction aggregate) and for disposal (use of existing quarries, disposal in landfills). Proposed disposition of spoils in Texas is presented in Section 10.2.3.7 of Appendix 10. No potentially harmful leachate has been identified in the rocks to be tunneled, so leachate production should not be a problem. The reuse alternatives involve potential impacts from erosion and washoff of sediment; however, such impacts would be no larger than already exist in the area for these operations. Landfills have permits because they can demonstrate surface and groundwater controls that would contain this material. Therefore, disposal of tunnel spoils in landfills should cause a negligible impact to surface water quality.

Increases to wastewater discharge would come from a new campus area sewage treatment plant to be constructed near the injector facility to serve the campus area, and from a package tertiary treatment system that would be installed at the far cluster. Assuming the sewage effluent would be discharged into a Chambers Creek watershed tributary, the campus area treatment plant would require a new NPDES permit. This could have an impact to the water quality of the tributary, but probably not to the water quality of Chambers Creek. However, because the effluent would have tertiary treatment, would be regulated by the NPDES permit, and would discharge to an intermittent stream, the impact should not be significant. Remote services areas will use septic tank and leach fields for sanitary wastewater disposal.

Off-site wastewater increases would be most significant in Dallas and Ellis counties, where population in-migration would be greatest. Dallas County population increases are expected to be about 4,800 people by the peak construction year of 1992. Ellis County can expect an increase of 2,700 people over the same time. Using an approximate figure of 100 gal/d/capita for wastewater increases, the additional treatment necessary in each of these counties would be 480,000 gal/d and 270,000 gal/d, respectively. Expressed as a percentage of the combined, available capacity for all treatment plants in each of these counties, the increases represent about 6 percent of the available capacity in Dallas County and 20 percent of the existing available capacity in Ellis County. As these wastewater increases are well within the existing permitted capacities of the treatment plants (Texas Water Commission, Wastewater Enforcement Section 1988), the impacts should be negligible.

No regional impacts to surface water quality are expected. The loadings from erosion, etc., would be localized when present, and the areas of potential impact are scattered around the ring among several watersheds.

## 2. Operations

The major area of concern for impacts to surface water quality associated with SSC operations is wastewater and/or cooling tower blowdown. Wastewater and cooling tower blowdown from the campus area would be pretreated and sent to the new treatment plant in the injector area. The remaining cooling tower blowdown water will be sent to a centralized 396-acre evaporation pond.

This increase in wastewater during operations would be about 150,000 gal/d of sewage and 100,000 to 150,000 gal/d of cooling tower blowdown, and would be processed at a plant not currently in operation. It would be a new discharge on a tributary that does not presently receive any wastewater effluents, which could cause an impact on the water quality of this tributary. However, this wastewater would go through tertiary treatment and be regulated by an NPDES permit. In addition, this tributary is an intermittent stream. Therefore, this impact is not expected to be significant.

Off-site wastewater increases from Dallas and Ellis counties during operations would be about 380,000 and 230,000 gal/d, respectively. This is about 4 percent of the available treatment capacity in Dallas County and 17 percent of the available capacity in Ellis County. This is a small part of the available capacity in each of these counties (Texas Water Commission, Wastewater Enforcement Section 1988). Because these increases are well within the permitted capacity of existing plants, the impact to surface water quality should be negligible.

## G. Surface Water Use

### 1. Construction

Surface water is proposed to supply only the campus and near cluster areas. Groundwater would be the source of water supplied to the far cluster and remote locations.

General water use during construction has been estimated for the period 1989 to 1995 for the facility, and this is included in Table 7-1. Off-site water use during construction has been estimated by county for the Texas site, and is given in Table 7-8.

The surface water source is the Tarrant County Water Control and Improvement District No. 1 (TCWC & ID No. 1). Their water currently comes from Cedar Creek Reservoir (Tarrant County Water Control and Improvement District No. 1 1987). In 1985, water supplied from this reservoir amounted to 181,000 acre-ft. Their projected water use for the year 2000 would be approximately 300,000 acre-ft/yr. Richland Chambers Reservoir is scheduled to be completed this year bringing the total firm yield from both reservoirs to 470,000 acre-ft/yr. This would mean an available excess of about 290,000 acre-ft/yr now and about 170,000 acre-ft/yr by the year 2000.

Peak construction period water use would be about 88 acre-ft/yr in 1992 for direct facility construction use. Off-site peak water use for Tarrant County is estimated to be about 365 acre-ft in 1992, to make a total 1992 SSC demand of 450 acre-ft. This would be about 0.3 percent of the expected excess water available in the year 2000. This would be a negligible impact to the surface water use in Tarrant County.

### 2. Operations

Industrial and potable water supplies required for operation of the SSC campus (Table 7-1) will be obtained from Cedar Creek Reservoir operated by the Tarrant County Water Control and Improvement District and will total about 1,395 acre-ft/yr. Off-site water needs for the Tarrant County area that are estimated at 210 to 280 acre-ft/yr will also be obtained from this reservoir. The resulting total annual demand from this water supply system will be a maximum of 1,675 acre-ft/yr or about 1 percent of the projected excess from this reservoir in the year 2000.

Other off-site water uses during the operations period will be met by the water supply systems in the affected counties. The off-site water use in Ellis and Dallas counties are estimated to total 835 to 1,090 acre-ft/yr. It is estimated that approximately 88 percent of this water will be obtained from surface water sources and that this represents less than 1 percent of the total surface water provided through municipal water systems within these counties. The remaining off-site uses will be dispersed among water systems in six other counties. The impact of these off-site uses on existing systems is negligible.

Table 7-8

**ESTIMATED OFF-SITE DOMESTIC WATER USE  
DURING SSC CONSTRUCTION AND OPERATIONS IN TEXAS<sup>1</sup>**

Location	Water Use During Construction (acre-ft/yr)						Water Use During Operations (acre-ft/yr)	
	1989	1990	1991	1992	1993	1994	1995	
Ellis County	65	245	450	480	430	470	410	320 - 415
Dallas County	125	440	810	850	745	790	660	515 - 675
Tarrant County	55	190	355	365	320	335	275	210 - 280
Other Nearby Counties <sup>2</sup>	<u>10</u>	<u>40</u>	<u>75</u>	<u>75</u>	<u>65</u>	<u>70</u>	<u>55</u>	<u>45 - 55</u>
TOTAL	255	915	1,690	1,770	1,560	1,665	1,400	1,090 - 1,425

1. Estimated domestic water use is based on population projections multiplied by a factor of 160 gal/d capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Texas. The estimates do not include water delivered for industrial and commercial use.
2. Includes estimates for Hill, Johnson, Kaufman, Navarro, and Rockwall counties.

## 7.2 GROUNDWATER

### 7.2.1 Purpose and Scope

The purpose of the groundwater resources assessment is to identify and evaluate the impacts to groundwater hydrology, quality, and use at the proposed sites resulting from SSC construction and operations.

The term "groundwater resources" refers to the occurrence, movement, quality, quantity, and availability of water beneath the land surface. Assessment of potential impacts to groundwater resources includes consideration of impacts to both the physical hydrogeologic system and the existing pattern of groundwater use.

The scope of the groundwater resources assessment is to: 1) assess the magnitude and scale of potential impacts of the SSC project on groundwater hydrology, quality, and use; 2) identify, evaluate, and suggest mitigation measures; and 3) assess the significance of unmitigable impacts.

### 7.2.2 Technical Approach and Methodology

#### 7.2.2.1 Conceptual Basis

##### A. Level of Resolution

##### 1. Temporal

The groundwater resources impact assessment focuses on SSC construction and operations. Construction encompasses the period from initial site clearing until all construction and site restoration work is completed. Operations encompasses the period from full system testing until site decommissioning is initiated. Six impact categories or types are identified for groundwater resources. These are water levels/overdraft, recharge, subsidence, water quality, public water supply systems, and wells. All six categories are assessed for construction. Impact categories are reassessed for operations only if new source terms associated with operations occur or if there is a substantial change in the magnitude of a source term from construction to operations.

Impacts identified during the groundwater resources assessment were characterized as short-term, long-term, or irreversible. Short-term impacts are those whose duration is limited to the period of active construction or to a 1- to 2-yr time period during operations. Long-term impacts are those whose duration would extend for a number of years beyond construction or would occur throughout and for a number of years beyond operations.

##### 2. Spatial

Project impacts were assessed at the site and regional level. For groundwater resources, the site is defined as the area within 1 to 2 mi of the proposed ring alignment, and areas within a 2-mi radius of any proposed

project water supply wells or well fields outside the basic site area. The region encompasses the groundwater basins or aquifer areas within which the SSC facility is located, and within which any direct or indirect project groundwater use occurs.

## B. Impact Assessment Process and Terminology

For both construction and operations, groundwater resource impacts are identified based on potential project-induced changes to the existing environment. Discussions of the affected environment for each site are presented in Appendix 5.

Elements considered in each of the six impact categories introduced above, and the project activities or factors (source terms) affecting each, are described below in Section 7.2.2.2, Assessment Methodologies.

The impact assessment process first involves an evaluation of magnitude and scale (site or regional) of each impact type. Magnitude is characterized at three levels: no impact, negligible impact, and measurable impact. Standard, good construction practices and further possible site-specific mitigations for each impact are then identified and discussed. Based on the assumed effectiveness of mitigation measures, residual impacts are identified and the significance of residual impacts is evaluated. Measurable and significant impacts were characterized as short-term, long-term, or irreversible.

### 1. Impact Magnitude

The magnitude of project impacts on groundwater resources is assessed according to the following definitions:

- o No impact - No project-related activity is anticipated that could result in an impact of the type being considered, or there would be no opportunity for change in the physical groundwater system, groundwater quality, or groundwater use or use patterns.
- o Negligible impact - The amount of change from baseline, or existing conditions would not result in a decrease in long-term groundwater availability, or require a change in groundwater use or use patterns.
- o Measurable impact - The amount of change from baseline or existing conditions would result in some decrease in long-term groundwater availability or would require some change in groundwater use or use patterns.



## 2. Impact Mitigation

Impact mitigations are construction or operations activities, procedures, or methods whose application would reduce the magnitude of project impacts. Standard and potential SSC project-specific mitigations are outlined in Section 7.2.2.2, Assessment Methodologies.

## 3. Impact Significance

The residual impacts (after mitigations) were considered significant if one or more of the following conditions are likely:

- o Violation of a Federal, State, or local groundwater regulation.
- o Changes in water levels, recharge/discharge, or groundwater quality to an extent that existing local or regional groundwater use patterns are changed.
- o Initiation of overdraft or a notable increase in groundwater withdrawal from an already overdrafted groundwater basin or aquifer.
- o Substantial expansion of source (new wells) and/or treatment/distribution systems of existing public groundwater supply systems.
- o Measurable reduction of discharge from springs or lowering of water levels in wetland areas.

### 7.2.2.2 Assessment Methodologies

Six potential impact categories for groundwater resources during SSC construction and operations were identified in Section 7.2.2.1.A. For each impact type listed, the following sections discuss the project activities potentially causing the impact, data, and methodologies used to assess impact magnitude, and standard and potential site-specific impact mitigations. Impact assessment methodologies are related to site data availability. Limited hydrologic and water use data were available for certain sites. These data limitations are identified in the individual site impact assessments.

#### A. Water Levels/Overdraft

##### 1. Impact Assessment Method

Water level changes and/or basin or aquifer overdraft may result from project or project-related water supply withdrawals and from dewatering and groundwater inflow control. Project water supply withdrawals would occur during both construction and operations. Dewatering and groundwater inflow would occur primarily during construction, although some level of groundwater inflow control, such as sump pumps, may have to be maintained in most sites throughout operations.

Data to assess impacts include, as available, aquifer recharge and storage; safe, perennial or annual yield; water level history and trends; hydraulic properties of aquifers; historical, present, and projected water use and estimated project water use; and dewatering requirements and projected areas of pumping. Data used in impact assessment were derived directly from SSC siting studies, as well as from Federal and State agency files and publications. Data from private (non-governmental) sources were used only as necessary to provide data sets as complete as possible.

Impact was assessed by numerical comparison of estimated project groundwater withdrawals and present and projected groundwater use in the site vicinity with current aquifer recharge, storage, and/or yield. The density and location of present groundwater use (well locations) were considered in assessing impact magnitude. Simple drawdown calculations were used as appropriate to assess water level impacts.

## 2. Impact Mitigation

There are limited mitigation options for water level and overdrafting impacts associated with direct or indirect project water supply withdrawals. Alternative pumping locations or patterns can be developed if the location of pumping and associated water level declines is the primary factor. An alternative water supply source is the most effective mitigation if significant water level declines and/or overdraft impacts are anticipated.

The primary mitigation for dewatering pumping impacts is to maximize the use of nonwithdrawal groundwater control techniques, such as slurry walls and freezing, and tunnel grouting or lining.

The assessments will identify mitigations that would be considered further during final site design.

### B. Recharge

#### 1. Impact Assessment Method

A change in groundwater recharge may result from soil compaction, construction of impervious surfaces and modification of drainage patterns and, consequently, surface water retention. Soil compaction, initial construction of impervious surfaces, and site drainage modification all occur during construction. Soil compaction effects are generally short-term and would not extend beyond construction. Impervious surfaces (e.g., roads, buildings, parking lots) and drainage modification effects generally remain throughout the project's operations.

Data to assess impacts include, as available, aquifer recharge and recharge area, and project construction plans, including the estimated amount of disturbed area at each proposed site and the approximate area of buildings and pavement.

Impact was assessed by comparison of the amount of recharge area available before construction of the SSC with the amount of recharge area lost due to construction.

## 2. Impact Mitigation

Mitigation options for impacts to groundwater recharge are relatively straightforward. Standard good construction practices are to minimize the amount of impervious area created and the amount of area disturbed by construction activities. In areas where construction is extensive and/or natural drainage and recharge patterns may be notably modified, recharge basins can be constructed within the site to minimize disruption or change in natural groundwater recharge in the site vicinity. The following assessments identify mitigation measures that would be considered further during site design.

### C. Subsidence

#### 1. Impact Assessment Method

Subsidence may result from project or project-related water supply withdrawals, during both construction and operations. Data to assess impacts include site stratigraphy and lithology, specifically the sequence of hydrogeologic units, down to and including units proposed as a groundwater supply source, and direct and indirect project water supply requirements.

Impacts were assessed by evaluating the correspondence between site stratigraphy and "typical" stratigraphy prone to subsidence, i.e., a sequence of non- or minimally-indurated, fine-grained sediments from which groundwater may be withdrawn. Where stratigraphic conditions are appropriate for the occurrence of subsidence, the amount and stratigraphic location of any proposed project or project-related groundwater withdrawals were numerically compared to the level of existing withdrawals and subsidence.

#### 2. Impact Mitigation

There are limited mitigation options for the potential occurrence of subsidence related to direct or indirect project groundwater withdrawals. Some level of mitigation may be achieved by altering planned pumping locations or patterns. Identification of an alternative water supply source is the most logical mitigation, if alternative supply sources are practical or available. The following assessments identify mitigations that would be considered further during final project design.

## D. Water Quality

### 1. Impact Assessment Method

Groundwater quality changes may result from project or project-related water supply withdrawals during construction and operations, from surface and subsurface activities during construction, and from surface and subsurface activities during operations. Construction activities or materials that could impact groundwater quality include equipment operation and maintenance, spills and leaks of construction materials, soil disturbance, emplacement of materials in the subsurface (such as concrete grout and liners of metallic or other construction), temporary storage and disposal of dewatering or groundwater inflow control wastewater, temporary storage and disposal of spoils, sewage effluent associated with construction personnel (especially where treatment involves lagoons or leach fields), and any new landfills established for disposal of solid construction wastes. Operations activities and materials that could impact groundwater quality include vehicle and equipment maintenance and operation, landscaping and site maintenance (e.g., fertilizers and pesticides, and salt for snow and ice control), increased sewage effluent associated with operations personnel (especially where treatment involves lagoons or leach fields), any new landfills established for disposal of operational solid waste, and cooling tower blowdown.

Data to assess impacts include, as available, groundwater quality, recharge and infiltration, depth to water, extent and nature of use of shallow groundwater resources, project water supply requirements, and general plans and procedures for SSC construction and operations.

Impact was assessed considering shallow groundwater quality, water quality standards applicable to groundwater (generally Federal drinking water standards), and existing groundwater use and the planned level and type of construction activity, water use, and waste disposal at each proposed site. The amount of potential change in groundwater quality would be compared to present quality and applicable standards to assess impact magnitude.

### 2. Impact Mitigation

Several standard, good construction practices would be applied to minimize groundwater quality impacts from normal construction and operations. These include in-place spill and leak response procedures, spill and leak containment designs or structures (e.g., lined ponds) for materials with significant groundwater contamination potential, and established materials handling procedures. Wastewater can be treated prior to discharge or ponding to remove or minimize the groundwater contamination potential.

In areas where shallow groundwater is especially sensitive to contamination impacts, limitations could be placed on the use of materials such as fertilizers and pesticides, and the use of salt for road and walkway

de-icing. Groundwater quality deterioration caused by groundwater withdrawals and consequent in-migration of poorer quality groundwater could be mitigated by reducing or relocating planned groundwater pumpage, or by substituting an alternative water supply source.

#### E. Public Water Supply Systems

##### 1. Impact Assessment Method

Expansions or other upgrades to local public water supply systems with groundwater supply sources may be required as a result of in-migration of project personnel and dependents, and indirect population growth associated with project construction and operations. This in-migration would affect communities in the immediate site vicinity as well as areas and communities some distance from the site.

Data to assess impacts include, as available, projected population increases related to the project (from Appendix 14), existing and projected groundwater use, and existing water supply, treatment and distribution capacity of impacted communities. Population numbers are converted to water requirements by applying state-specific per capita domestic water use figures derived from Solley et al. (1983).

Impact was assessed by comparison of potential increased water supply requirements with existing community water use, and existing and planned system capacity. Where population in-migration is projected only at the county level rather than by community, impacts were evaluated qualitatively assuming that the increased water use was distributed throughout the communities in the affected counties.

##### 2. Impact Mitigation

There are no effective mitigations for the direct physical impact or requirement for expansion of a community water treatment and distribution system. The need for expansion could be delayed by implementing water-saving measures. However, the effectiveness of these measures would be dependent upon their acceptance by the users. Most of the water use for construction, and some of the use for operations would be consumptive, with little or no opportunity for reuse. This water use would be largely unmitigable. Impacts to a specific source can be mitigated by developing an alternative source, if any are available.

#### F. Wells

##### 1. Impact Assessment Method

Some portion of existing wells on land acquired in both fee simple and stratified fee estate for SSC project facilities, within the 1,000-ft restricted zone along the tunnel, or within the buried beam zone buffer and access areas, may have to be abandoned. This impact may occur

either during project land acquisition or during construction. Data used to assess the impact of well abandonment include the number, location, and use of wells sited within potentially affected areas. Impacts were assessed based on the estimated or recorded number of wells and the approximate amount of water use affected.

The number of water wells within the SSC footprint (1,000-ft corridor along tunnel, campus, injector and far cluster areas, and buried beam zone and buffer areas) and the number that may have to be closed due to proximity to SSC facilities, are estimated based on available state and local well records and proposed siting of SSC facilities. These data are adequate for assessment at this level. More detailed evaluation of well records and locations will be undertaken for the selected site and will be presented in the Supplement to the EIS.

Some potential exists for construction-related damage to wells in the immediate vicinity of a construction site (e.g., cracks in well casings due to blast vibrations). However, wells within this zone of influence would likely have been abandoned due to location within a fee-simple area, or due to a well depth in a stratified fee area where conflicts with tunnel operation or construction may occur.

## 2. Impact Mitigation

The impact of forced well closures, or damage to wells, could be partially mitigated by providing the affected well owner with a replacement well or by providing access to an alternative water supply source of equal or better water quality. In certain cases, if land associated with the well was purchased for the project, there may be no need for a replacement well or water supply. All of the states have indicated that replacement wells or alternative water supplies of equal or better quality would be provided to owners of wells which must be abandoned due to SSC project siting or construction.

### 7.2.3 Resource Assessments

Location of the SSC at any of the seven proposed sites would result in increased water demands locally.

Estimated on-site construction and operations water use and off-site domestic water use associated with the project are summarized in Table 7-1 (Section 7.1.3 of this Appendix). The portion of this estimated total use to be provided by groundwater is defined in the individual site resource assessments and is used as a source term to assess impacts.

### 7.2.3.1 Arizona

#### A. Construction

##### 1. Water Levels/Overdraft

Groundwater is the proposed water supply source for all direct SSC water requirements in Arizona. The specific proposed sources are three existing large-capacity wells located approximately 0.5-mi south of Highway 8 in northern Vekol Valley (Figure 7-1). The water would be piped to the site and then through a pipeline into the SSC tunnel to all project water use points. Prior to pipeline installation, water would presumably be trucked from the supply point or the current pipeline terminus to construction sites.

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of immigration of construction workers and their dependents and due to secondarily induced population growth. This estimated water use is shown in Table 7-2. It varies from 365 acre-ft in 1989 to 2,300 acre-ft in 1992, and totals about 11,900 acre-ft for the planned 7-yr construction period. Operations indirect water use is anticipated to range from 1,375 to 1,820 acre-ft/yr. About 70 percent of the increase in indirect water use would occur in the Phoenix metropolitan area; the remainder would occur in other communities in Maricopa, Pinal, and Pima counties. Many of the communities in this area rely heavily on groundwater for municipal supply. Although Phoenix receives surface water from the Salt River Project, many communities, including Phoenix, are presently increasing use of surface water available from the Central Arizona Project (CAP).

As shown in Table 7-1, the peak year of construction is 1992 when about 88 acre-ft of water would be required. The total 7-yr construction period water use is estimated to be about 343 acre-ft. The amount of water use projected is equivalent to a full-time pumping rate (24 hr/d, 365 d/yr) from 3 to 55 gal/min and would average about 30 gal/min for the construction period. This would produce a discernible water level decline in the near vicinity of the supply wells, although perhaps only several tens of feet as the wells are quite efficient. However, there are no existing wells near the proposed supply wells, and the water level overdraft impact from direct construction water withdrawals would be negligible.

The estimated recharge to northern Vekol Valley is about 1,200 acre-ft/yr. Current baseline water use in Vekol Valley is estimated at 50 acre-ft/yr or 4 percent of annual recharge to the groundwater basin. The SSC project is estimated to have a peak-year construction water use of 88 acre-ft which represents 7 percent of the annual recharge to the groundwater basin. The SSC project would be the only substantial user of Vekol Valley water. As a result, the level of change caused by the

project over current baseline water use is a negligible impact and would not result in either an overdraft or a decrease in groundwater availability in northern Vekol Valley.

Water level/overdraft impacts from indirect project water use during construction and continuing throughout operations would be negligible. Approximately 70 percent of the total increased use, or about 8,330 acre-ft, would occur in the Phoenix area, and increased water use in the Phoenix area would be provided by CAP water rather than from current surface supplies and from groundwater resources that are presently heavily overdrafted. Some portion of the remainder of indirect water use, a total of about 3,570 acre-ft, may occur in communities not receiving CAP water or other surface water and local groundwater withdrawals may be increased. The communities of Avondale, Buckeye, Gila Bend, and Maricopa, that might experience increased water demands, each pumped from 400 to over 8,000 acre-ft of groundwater in 1985 to supply municipal and industrial customers. However, since the use would be distributed among a number of these communities, there would be only a negligible water level/overdraft impact in any given area or basin affected. Increased rural groundwater use would be minimal and would have no water level/overdraft impact.

The depth-to-water at the Arizona site is approximately 350 ft and is well below the tunnel. There would be no dewatering or groundwater inflow control activities and consequently no related water level/overdraft impacts.

## 2. Recharge

Recharge to groundwater basins in Arizona occurs predominantly along the mountain fronts or edges of the basins with little, if any, occurring on the basin floors where the project would be located. Based on the description of project facilities and construction in Appendix 1, about 3.5 mi<sup>2</sup> of land would be disturbed by construction or would have project facilities built on it that could impede recharge. Since most of this limited area would be on basin floor rather than mountain front terrain, there would be only a negligible, if any, impact to basin recharge.

## 3. Subsidence

There would be no subsidence caused by construction groundwater withdrawals at the Arizona site. The amount of groundwater withdrawn for construction purposes would not lower groundwater levels a sufficient amount to promote subsidence. Subsidence typically occurs in alluvial valleys when water levels are lowered 150 to 300 ft in sediments that contain significant amounts of clay that can be compacted. It is anticipated that groundwater withdrawals for construction would result in local declines in water levels near the production wells in the tens of feet, and regionally would not be measurable.



#### 4. Water Quality

There would be no groundwater quality impacts from surface and subsurface construction activities and groundwater use associated with project construction at the Arizona site. The water table is well below tunnel depth throughout the site and recharge is inadequate to transport any surface- or tunnel-derived contaminants to the water table. In Arizona, water quality deterioration typically occurs in areas where significant agricultural activity has occurred and in some areas where high salinity groundwater is encountered at depth. Water quality deterioration can occur when these poorer quality waters migrate into areas of better quality because of significant declines in water levels. It is anticipated that groundwater withdrawals for construction uses at the site would result in water level declines that would locally be in tens of feet and regionally not measurable. There is also no direct evidence that poorer quality water exists at depth in northern Vekol Valley.

Approximately 2.45 million yd<sup>3</sup> of spoils would be generated from shafts and the tunnel at the Arizona site. The material would be mixed alluvium and a variety of igneous and metamorphic rock types. Following temporary near-shaft or cut-and-cover area stockpiling, the spoils would be disposed by 1) transport to either of two abandoned open-pit mines in the vicinity, 2) spreading over a 1 mi<sup>2</sup> area on the project site, or 3) transport to Phoenix to be used as building material. Given the relatively low leachate generation potential of the material, the very low rainfall, the generally great depth to water on site, and assuming the material is not placed in standing groundwater in the open-pit mines, none of the disposal options should have any impact on local groundwater quality.

Solid waste generated on site during construction and subsequent operations would be disposed of at a new state-licensed landfill to be developed on or near the project site. Disposal could also occur at one of several nearby existing landfills. There would be no groundwater quality impacts from either option.

Groundwater quality impacts (related to construction and continuing operations) on indirect water use would be negligible. Most of the indirect water use would occur in the Phoenix area and it is likely that increased use related to the project would be met with CAP water rather than by increased groundwater use. Groundwater use could increase in other communities near Phoenix or in Pinal and Pima counties to meet project indirect water needs, and some modification of local groundwater quality could result. Given the apparent distribution of increased water use, only a negligible impact would be anticipated in any given area.

## 5. Public Water Supply Systems

The estimated off-site rural and municipal water use associated with the project in Arizona is summarized in Table 7-2. The impact to existing public water supply systems from the project-related demand during construction and subsequent operations would be negligible. Project-related water use in the Phoenix area would range from 250 to 1,540 acre-ft/yr during construction and would be about 1,000 acre-ft/yr during operations. Present municipal water use in the Phoenix area is more than 300,000 acre-ft/yr and an increase of less than 2,000 acre-ft/yr is less than 1 percent of present use; while not insignificant, this should be only a negligible impact on existing systems. The Phoenix area water supply systems have been in a growth mode for many years based on both groundwater and surface water use, and this growth is continuing, now based more on CAP water than expanded groundwater use.

The impact to groundwater-based public supply systems throughout the rest of Maricopa, Pinal, and Pima counties would also be negligible. The communities of Avondale, Buckeye, Gila Bend, and Maricopa, that might be affected by indirect project water uses, have water systems in place that provided municipal and industrial customers with a total of 13,280 acre-ft of groundwater in 1985. Most of these systems report decreased water use in recent years (Welty 1988). The anticipated increased water needs would be sufficiently disbursed throughout these areas so that no single water supply system would be measurably impacted.

## 6. Wells

There are no known wells within the SSC footprint.

### B. Operations

#### 1. Water Levels/Overdraft

Water level/overdraft impacts from direct project water withdrawals would be measurable and long-term at the regional level. As shown in Table 7-1, the annual total projected on-site water use for operations is 2,175 acre-ft, which would all be derived from the well field in Vekol Valley. The required withdrawals are equivalent to a continuous pumping rate of 1,350 gal/min or 450 gal/min/well if three wells are used. This level of pumping should result in long-term drawdowns of several tens of feet at distances of 1 mi or so from the wells. However, there is no other groundwater use in the area to be affected by such a drawdown.

Overdrafting of the groundwater basin may be indicated because annual total withdrawals (SSC and other users) of 2,225 acre-ft would exceed the estimated annual recharge (1,200 acre-ft) to the northern Vekol Valley groundwater basin. Estimated annual recharge values are only approximate, and the difference between 1,200 acre-ft/yr and 2,200 acre-ft/yr may not be sufficient to promote regional water level

declines. It is estimated that from 2 to 3.1 million acre-ft of groundwater is in storage in the northern Vekol Valley groundwater basin and if pumpage were to exceed recharge by 1,000 acre-ft/yr for the life of the project, only 30,000 acre-ft of groundwater would be withdrawn from storage in the Vekol Valley. This represents less than 1 percent of the groundwater in storage. Although the State of Arizona has historically allowed overdrafting of groundwater basins and will continue to allow overdrafting until the year 2025, the impact of groundwater withdrawals for operations water use would be measurable; other new groundwater uses may be limited or restricted.

A potential mitigation for water level and overdraft impacts is importation and use of CAP water for all or a portion of operations industrial water requirements. This however would result in other impacts from pipeline construction and limiting other uses of CAP water.

## 2. Subsidence

There would be a negligible subsidence impact caused by construction or during continuing operations due to groundwater withdrawals. Anticipated areal groundwater withdrawals are not expected to be large enough to dewater a significant portion of clay layers that may exist at depth. Groundwater withdrawal may produce water level declines in the upper tens of feet locally, but only a few feet regionally. Drawdowns of this magnitude should not result in detectable subsidence at the well site or at any other location in the area.

## 3. Water Quality

There would be no groundwater quality impacts from surface or subsurface operations because of the depth to groundwater (approximately 350 ft) and the very limited infiltration and recharge at the site.

Domestic sewage would be treated at a new permitted tertiary plant at the campus area. Experimental and service areas would have permitted package plants with an evaporation pond and septic tanks with leach fields, respectively. Cooling tower blowdown would be disposed of in an evaporation pond with landfill disposal of residual salts. Assuming the ponds are lined to preclude or minimize infiltration, there would be a zero or negligible impact to groundwater quality. These activities would have no impact on groundwater quality for the same reasons as stated above.

Groundwater quality impacts from operations indirect groundwater use were previously defined as negligible (see Section 7.2.3.1.A.4, Construction - Water Quality).

### 7 2.3.2 Colorado

#### A. Construction

##### 1. Water Levels/Overdraft

Groundwater from alluvial deposits along stream channels in the South Platte River basin would be the proposed supply source for all direct construction water requirements for the SSC project in Colorado. This source is within the Morgan County Quality Water District (MCQWD). The MCQWD currently obtains water from the Hay Gulch aquifer in the Lost Creek basin. That aquifer is considered nontributary to the South Platte River, and, therefore, augmentation water is not required. The MCQWD also has two additional wells located outside the Hay Gulch well field that are considered tributary to the South Platte River, and augmentation would be required by state law. Three sources of augmentation have been proposed by the State 1) purchase of South Platte River basin surface water rights; 2) purchase of South Platte River basin groundwater rights; and 3) purchase of existing allocations of Colorado-Big Thompson project water that currently are used in the South Platte River basin. No additional transfers of west slope water to the South Platte River basin would result from the proposed project. Although specific well locations are not defined, the general locations where groundwater would be used can be identified on Figure 7-2. Presumably, purchased wells and water rights would be distributed around the ring.

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of in-migration of construction workers and operations personnel and their dependents. The estimated water use is shown in the Table 7-3. It varies from 280 acre-ft in 1989 to a high of 1,870 acre-ft in 1992 and totals 9,700 acre-ft for the planned 7-yr construction period. Operations period indirect water use is anticipated to range from about 1,000 to 1,400 acre-ft/yr. Most of the increased water use would occur in Morgan County and in the Denver area to the west; minor increases are projected in 12 other counties surrounding the site. Surface water is the primary municipal water supply source in the Denver municipal area. Groundwater sources are more important in rural areas.

Water level/overdraft impacts from direct project water withdrawals for construction would be negligible. Total estimated direct water use for construction is shown on Table 7-1. It ranges from 5 to 88 acre-ft/yr and totals 343 acre-ft for the 7-yr construction period. Even if a limited number of wells were devoted to supplying water for the project, withdrawals on the order of only 10 acre-ft/yr at any individual well are likely. This is equivalent to a full-time pumping rate of less than 10 gal/min, which would not result in measurable water level declines at any distance from the pumping wells. Although local groundwater recharge rates are not well defined, the pumpage is very small and should not result in a regional or localized overdraft condition.

Increased groundwater withdrawal from the wells located in the South Platte River basin would require augmentation. The transfer of groundwater rights and use by purchase is an established and regulated procedure in Colorado. The limited amount of water rights involved for direct project construction use suggests a negligible impact to existing water users. By transferring water rights, there may be no net increase in local groundwater use and groundwater use patterns would not be measurably modified. The impacts to surface water sources because of purchase of surface rights are discussed in Section 7.2.3.1.

Water level/overdraft impacts from indirect project water use during construction and continuing through operations would also be negligible. The great majority of projected increases would occur in Morgan County (Fort Morgan and City of Brush) and in the Denver area to the west. The Denver Water Department supplied 230,666 acre-ft of water in 1987, all of which was surface water, and it is estimated that only about 5 percent of the water supply in the Denver Metro area is from groundwater sources. Thus, increased water use in the Denver area ranging from 100 to perhaps 600 acre-ft/yr during construction and averaging about 400 acre-ft during operations would have a negligible impact on groundwater resources in this area (Simpson 1988b). Increased rural and municipal indirect water use in Morgan County would range from about 100 to 800 acre-ft/yr over the construction period and average about 500 to 600 acre-ft/yr through operations. Fort Morgan presently pumps 3,400 acre-ft of groundwater per year and projects that it will use 3,800 acre-ft by the year 2000. The City of Brush presently uses 1,265 acre-ft per year and projects that it will use 1,765 acre-ft by 1995 (Simpson 1988b). Distribution of this increase in demand between Fort Morgan and the City of Brush well field areas, which are not presently overdrafted, would result in only negligible water level or overdraft impacts locally. The small remaining projected indirect water use would be distributed among 12 counties and should result in no water level/overdraft impacts.

At the Colorado site some groundwater control would be required for construction of building foundations, the booster/injector complex, and shafts that penetrate the surficial dune sand, loess, and alluvial deposits. If dewatering these construction areas by pumping from well points or wells is employed extensively, a measurable site level short-term impact to groundwater levels may occur. The amount of dewatering pumping potentially required cannot be estimated until the preconstruction geotechnical surveys are complete; if extensive pumping is required, however, water levels in nearby wells could be affected. To mitigate this potential dewatering impact, groundwater control could be achieved by freezing or slurry wall techniques and by grouting. If only minimal dewatering pumping is required, water level/overdraft impact would be negligible.

It is not anticipated that dewatering would be required for tunnel construction because Pierre shale is a poor water conductor. Consequently, there would be no water level/overdraft impact from tunnel construction.

No measurable groundwater inflow is anticipated in unweathered Pierre shale, while discrete joints or fractures in weathered Pierre shale may yield inflows of a few tens of gal/min and require grouting.

## 2. Recharge

Recharge impacts caused by construction activities would be negligible. Recharge to the alluvial aquifers, the major aquifers in the project area, occurs primarily along the stream channels and during periods of streamflow. No data exist that characterize the total or unit area amount of recharge to these aquifers. Since project features (with the exception of J2, E3, F2, K3, K6, E8, and E1) would not be located in floodplains of the stream channels, the impact of the SSC facility will be negligible. The access road channels that would be constructed from the Denver area to the SSC site would cross stream channels, but these crossings would be such a small percentage of the recharge areas of any alluvial aquifer that impacts to recharge would also be negligible.

## 3. Subsidence

There would be no subsidence impacts caused by construction or continuing operations groundwater withdrawals. The subsurface stratigraphy at the Colorado site, a thin veneer of unconsolidated recent sediments overlying a thick sequence of claystone (Pierre shale), is not prone to subsidence even under heavy groundwater use or overdraft conditions.

## 4. Water Quality

Groundwater quality impacts from surface and subsurface construction and the minor groundwater use associated with construction would be negligible. This conclusion is based on the fact that site groundwaters are already characterized by relatively high levels of dissolved solutes (See Appendix 5, Table 5.5.2-5) and, therefore, are not highly sensitive to minor changes in common dissolved constituents caused by the standard construction materials and practices employed for the SSC project.

Because of the generally shallow depth-to-water typical of the area, minor and very localized water quality effects from surface disturbance, equipment operation, and minor leaks and spills of construction materials would be inevitable. These would be minimized by proper construction practices and use of normal industry procedures for spill and leak response and cleanup.

Some subsurface construction would occur within the shallow alluvial aquifers. Shaft construction and installation of concrete or steel liners would result in a negligible impact to groundwater quality in the vicinity of the shafts. Physical disturbance of aquifer material and the introduction of concrete or metal structures into an aquifer would affect only TDS and the common ions such as sulfate, sodium, calcium, and iron. Constituents commonly viewed as contaminants would not be anticipated in measurable amounts if standard practices, such as removing any oily coatings from liner sections before installation, are followed.

Any changes in groundwater quality would be very localized and, while changes may be locally detectable, there should be no change in potential use of the groundwater.

There would be no groundwater quality impacts from tunnel construction. The tunnel would be almost totally in unweathered Pierre shale beneath the alluvial aquifers in the area. There is little, if any, groundwater movement in the Pierre shale because of the very low hydraulic conductivity ( $10^{-4}$  to  $10^{-10}$  cm/s) (Colorado Geological Survey 1988). Consequently, there would be no movement of groundwater away from the tunnel even if contaminants were introduced. As an additional factor, it is planned to line the tunnel to prevent drying and slaking of the shale or, more properly, claystone.

As discussed earlier, dewatering is not expected to be necessary at the Colorado site. Therefore, minimal to no impacts to groundwater quality are expected.

It is anticipated that approximately 2.6-million  $\text{yd}^3$  of spoils would be generated from shafts and the tunnel. The material would be 98 percent Pierre shale (claystone) and 2 percent limestone and non-indurated material (channel alluvium, dune sand, and loess). The Pierre shale contains gypsum, which is an easily dissolved or leached material yielding primarily calcium and sulfate ions. Shallow groundwaters in the area are presently characterized by moderate to high levels of calcium and sulfate (Bjorklund and Brown 1957; Repplier et al. 1981).

Four spoils disposal options have been identified. These include three alternative construction uses (floodplain embankment, reservoir lining, and highway embankments) and disposal piles on state school land (eight sites totaling 115 acres with disposal piles at least 14 ft high).

It is presently planned that solid waste generated during construction and also during subsequent operations would be transported to one or more of several existing landfills near the site or that a new landfill would be developed on site. If disposal is to existing permitted landfills, it is assumed that controls to protect local groundwater quality are in place and that disposal of project waste would have little, if any, incremental effect on potential groundwater contamination from the landfill. If the option of a new on-site landfill is selected, it would be permitted, developed, and operated to all applicable standards. While, for any of these options, calcium and sulfate could be released from the gypsum in the spoils, the accompanying ground claystone would be a poor medium for leaching these ions from the spoils. Therefore, no measurable changes in water quality are expected in near-surface aquifers near the spoils.

Negligible groundwater quality impacts related to indirect groundwater use from in-migrants and secondary induced growth would occur. The distribution of pumpage over the well fields of a number of communities (individual service areas, Fort Morgan and city of Brush well fields, Hay Gulch well field, and exchange wells along the South Platte River) would be negligible at any one site because of the distributed nature of local water sources.

#### 5. Public Water Supply Systems

The estimated off-site rural and municipal water use associated with the project in Colorado is summarized in Table 7-3. The impact to existing groundwater-supplied public water systems from project-related demand during construction and operations would be negligible for the Denver area and rural counties surrounding the site but would be measurable for communities in Morgan County. As stated in the section on water level/overdraft impacts, increased water use in the Denver area is anticipated to range from about 100 to perhaps 600 acre-ft/yr during construction and average about 400 acre-ft/yr during operations. The Denver Water Department (the major water supplier in the Denver area) supplied a total of 283,718 acre-ft of water in 1987, all of which was from surface water sources (Simpson 1988b). Although specific information on groundwater-based system capacities has not been compiled for all Denver-area communities, it is logical to assume that the amount of increased use anticipated would only have a negligible impact on individual systems, because the metropolitan area is supplied largely by surface water sources and the use would be distributed throughout the Denver area.

Increased water use in counties surrounding the site (excluding Morgan County) is anticipated to range from about 20 to 500 acre-ft/yr during construction and to average about 300 acre-ft/yr during operations. Individual communities affected are not identified; however, given that this water use would be distributed throughout 12 counties (see Table 7-3) it is unlikely that there would be more than a negligible impact to any individual water supply system.

As shown in Table 7-3, off-site water use in Morgan County would range from 110 to 775 acre-ft/yr during construction and would average about 500 acre-ft/yr during operations. It is expected that the majority of this use would occur in Fort Morgan and Brush. The present water use in Fort Morgan and Brush is about 4,600 acre-ft/yr and the projected water use for the year 2000 is less than 6,000 acre-ft/yr. The present combined capacity of the two systems is about 9,000 acre-ft/yr. The City of Brush has a capacity in its wells to supply about 4,900 acre-ft/yr, while present use is about 1,200 acre-ft/yr. Fort Morgan has a capacity for producing 4,100 acre-ft/yr from its 14 wells and presently uses about 3,400 acre-ft/yr (Engineering Professionals, Inc. 1987, and Simpson 1988a). The increased water needs because of in-migration into the area represents approximately a 10 to 15 percent increase over base-line conditions. There is no effective mitigation for this increased



use. Although the increase would be measurable in terms of system operations, the basic systems for these communities can accommodate this amount of increased water use and, therefore, the impact would be not significant.

## 6. Wells

The impact of administrative (land acquisition) or safety-related (nearness to tunnel - within a 150-ft radius) well closures at the SSC site in Colorado would be negligible at the site level. It is estimated that less than 20 water wells occur within the SSC footprint. State records document 12 wells. All are domestic/stock or irrigation wells. Only a few of these wells may be directly affected and require abandonment because of the project. This would be a negligible impact on local water users and water use patterns. Well closures would be a minor beneficial impact for the local groundwater system.

The impact to water users can be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better quality are provided to affected well owners. The State has indicated that it will provide this mitigation. It is noted that the magnitude of this impact may change as well records and criteria for well closure are further defined.

### B. Operations

#### 1. Water Levels/Overdraft

The projected on-site or direct annual water use is higher during operations than during construction but water level/overdraft impacts would remain negligible. As shown in Table 7-1, the annual total projected direct water use for operations is about 2,175 acre-ft/yr. All water supplies would be derived from groundwater.

The operations water supply sources include groundwater from the Hay Gulch aquifer (potable water at the campus area) located approximately 35 mi northwest of the site (Figure 7-2), two wells located in the alluvial deposits adjacent to the South Platte River (industrial water at the campus area), and small-capacity wells located around the ring at service areas and the far cluster (industrial water). All water for the campus area would be provided by the Morgan County Quality Water District from existing wells in their supply system. Water for the far cluster and service areas would be from wells purchased by the State during the construction period.

Perceptible declines in water levels (tens of feet) would occur locally around the wells in the Hay Gulch aquifer, but the amount of change from baseline conditions would not result in a decrease in groundwater availability in the area. Annual recharge to the Hay Gulch aquifer is estimated to be about 7,000 acre-ft (Norton, Underwood and Lamb, Inc. 1988). Present water use of 800 acre-ft/yr is about 11 percent of the annual recharge and an increase of 400 acre-ft/yr for the campus potable water

requirements would increase water use to about 17 percent of natural recharge. This amount of increased water use would not result in a decrease in groundwater availability in the area nor, obviously, would it initiate any overdraft.

The groundwater that would be withdrawn from two of the MCQWD supply wells along the South Platte River would require augmentation as described in Section 7.2.3.2.A.1 (Figure 7-2) to compensate for any decrease in flow in the river caused by tributary groundwater withdrawals. This procedure is established in State water law and has been proposed by the State to provide the approximate 1,000 acre-ft/yr of industrial water for the campus area. Even though the process is a standard element of Colorado water law, it may be somewhat controversial, as are all water transfers in the western states. There would be no groundwater impacts (water levels/overdraft) from this plan, and the transferred surface water would not be available for other regional uses for the duration of the project.

Water level/overdraft impacts at the far cluster and service areas would also be negligible. It is anticipated that wells capable of producing 50-100 gal/min would be sufficient to supply these facilities. A small but perceptible impact to the groundwater system would occur locally around these wells. The amount of change from baseline conditions would not, however, measurably affect water levels in nearby wells or result in a decrease in groundwater availability in the area as the water rights and perhaps the wells themselves would be purchased.

Water level/overdraft impacts from indirect project water use during operations were previously assessed (see Section 7.2.3.2.A.1, Construction - Water Levels/Overdraft) as negligible.

## 2. Water Quality

Groundwater quality impacts from all aspects of operations would be negligible. Minor and very localized effects on groundwater quality from surface sources are inevitable given the generally shallow water table, especially in the alluvial deposits. These negligible impacts would result from routine site maintenance activities such as irrigation and fertilization of site landscaping, vehicle use, and snow and ice control during the winter. These impacts would be indistinguishable from the impacts to shallow aquifers from local farming and ranching operations. Given the nature and general quality of existing shallow groundwater (Appendix 5, Table 5.5.2-5), these types of sources should not measurably degrade existing conditions. Chemicals and other materials stored on site with contamination potential would be strictly controlled and procedures would be in place to rapidly respond to and clean up any spills or releases of such material.

Impacts to groundwater quality from subsurface activities would also be negligible. There would be limited materials in the tunnel/shaft environments with a potential to contaminate groundwater, and strict control

procedures would be in place for any such materials present. In addition, the tunnel rock unit (Pierre shale) has very low hydraulic conductivity with very few fractures or fracture zones where limited migration of contaminants introduced might be possible. The few fractures or fracture zones present would likely have been grouted during construction and, as mentioned previously, it is planned to place a liner in the tunnel in Colorado to help prevent drying and slaking of the Pierre shale. These factors would further limit the potential for any changes to groundwater quality from subsurface sources.

Handling and disposal of sewage and cooling tower blowdown generated during operations are described in detail in Appendix 10. Planned treatment and disposal would have only a negligible impact on groundwater quality. A new tertiary sewage treatment facility would be required in the vicinity of the campus area to treat domestic sewage from the campus, booster/injector, and near experimental areas. Sewage from the far cluster and remote service areas would be treated by a package tertiary treatment plant. Alternatively, septic tanks with disposal to leach fields or land application could be employed.

Any new wastewater treatment or package treatment plant would be permitted and constructed and operated to applicable standards and, consequently, negligible groundwater quality degradation would be anticipated. Septic tanks and leach fields always have a potential for measurable degradation of groundwater quality on a very localized scale. However, assuming that permitting and proper siting of disposal facilities within the surficial geologic deposits would occur, only a negligible impact is anticipated.

All cooling tower blowdown would be treated at the proposed 225-acre evaporation pond and would result in a negligible impact to groundwater quality. Assuming that the pond is lined to preclude or minimize infiltration, there would be a negligible impact to groundwater quality.

Groundwater quality impacts from direct and indirect project groundwater use and solid waste disposal during operations was previously assessed to be none or negligible (See Section 7.2.3.2.A.4, Construction - Water Quality).

### 7.2.3.3 Illinois

#### A. Construction

##### 1. Water Levels/Overdraft

Groundwater is the proposed water supply source for all direct SSC water requirements in Illinois. Surface water from the Fox River is offered as an alternative or backup supply source for industrial water at the main campus and as a source to maintain emergency fire fighting storage.

To meet estimated direct SSC requirements, groundwater sources are proposed as follows:

- o Main campus and associated experimental and service areas - Wells in upper bedrock (Silurian dolomite) aquifer; involves use or expansion of existing Fermilab well field.
- o Far cluster - Wells in the glacial drift or, as an alternative, in the basal portion of the Cambrian-Ordovician aquifer (Ironton-Galesville sandstone).
- o Service areas F3, F4, F6, F7, and F8 - Wells in the upper portion of the Cambrian-Ordovician aquifer (Glenwood-St. Peter sandstone).
- o Service areas F1, F2, and F9 - Service connections to the municipal supply systems for Aurora, Oswego, and St. Charles, respectively. Each of these communities presently obtains its water from the Cambrian-Ordovician aquifer.

Proposed sources are also areally distributed within the site vicinity. Locations of the general areas where groundwater would be developed are shown on Figure 7-3.

The proposed sources include three of the four major aquifer systems in the Illinois site vicinity: the glacial drift, the upper bedrock or Silurian dolomite aquifer, and the Cambrian-Ordovician aquifer. The combined sustained yield of the glacial drift and shallow bedrock aquifers within the vicinity of the Illinois site (including portions of Cook, DeKalb, DuPage, Kane, Kendall, and Will counties) is estimated to be 163,500 acre-ft/yr. The sustained yield of the Cambrian-Ordovician aquifer in the same region is estimated to be 29,200 to 32,500 acre-ft/yr. In DuPage and Kane counties the estimates of sustained yield for these upper and lower aquifers are 85,000 acre-ft/yr and 18,000 to 19,000 acre-ft/yr respectively (Visocky 1988).

Comparison of combined safe-yield and groundwater use data for the DuPage and Kane county areas suggests that overdraft conditions exist in the Cambrian-Ordovician aquifer and that overdraft may also be occurring locally in the shallow bedrock aquifer. Public water-supply systems in

these counties pumped 57,100 acre-ft of water from the Cambrian-Ordovician aquifer in 1986, approximately three times the estimated safe yield of 18,000 to 19,000 acre-ft/yr. Additional private pumping of unknown volume also occurred in the Cambrian-Ordovician aquifers during 1986. Insufficient information is available to discern the magnitude of any localized overdraft in the shallow-bedrock aquifer.

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of in-migration of construction workers and operations personnel and their dependents. This estimated water use is shown in Table 7-4. It varies from 125 acre-ft in 1989 to a high of 825 acre-ft in 1992 and totals 4,270 acre-ft for the planned 7-yr construction period. Operations water use is anticipated to range from about 500 to 700 acre-ft/yr. Most of the increased use would occur in communities and rural areas in DuPage, Kane, and Cook counties; minor increases are projected in six other counties surrounding the site (Boone, DeKalb, Kendall, Lake, McHenry, and Will). Most of the communities and rural users in these counties derive their water supply from groundwater. Importation of Lake Michigan water to reduce groundwater use has begun in the eastern part of the region and is projected to expand although there is no firm timetable for this to occur. Use of local surface water is also being considered.

Water level/overdraft impacts from direct construction water withdrawals would be negligible. As shown in Table 7-1, peak annual total projected water use for construction is 88 acre-ft in 1992. Projected construction water use is substantially less than this in several of the years and only totals about 340 acre-ft for the entire 7-yr construction period. This limited use would be derived from ten individual well fields or wells distributed around the proposed SSC site. The proposed source well fields or wells tap three of the four major aquifer units in the site vicinity. Given the limited amount of pumping that would be required at any individual well to meet construction water requirements, pumping would result in very small, localized, and transient water level declines, probably on the order of a few to a few tens of feet near and at the pumping wells. While a water level decline may be measurable in existing wells near proposed supply wells, the magnitude would be insufficient to affect regional supply availability or to impact water use. Two of the aquifers proposed as water supply sources, the upper bedrock or Silurian dolomite and the Cambrian-Ordovician aquifer, are locally overdrafted in the project vicinity. Present use in the immediate project area (assume Kane and DuPage counties, Figure 7-3) from each of these aquifers is on the order of 55,000 acre-ft/yr. The anticipated level of groundwater withdrawal for construction would slightly increase the level of overdraft but would not result in a measurable impact since it would not require a change in groundwater use patterns locally.

Water level/overdraft impacts from indirect project water use by immigrants and secondarily induced population growth during construction and continuing through operations would be measurable at the regional level and of long-term consequence. Given the present pattern of water use in the site vicinity, it must be assumed that most of the projected increase, ranging from 125 to over 800 acre-ft/yr (Table 7-4), would be derived from groundwater. Increased pumping would occur primarily from the glacial, upper bedrock, and Cambrian-Ordovician aquifers. Municipal use, which should be predominant, would be mostly from the latter two. The increased use would be distributed over a nine-county area within which recent (1986) groundwater use exceeds 310,000 acre-ft/yr. However, both the upper bedrock and Cambrian-Ordovician aquifers are locally or regionally overdrafted, as described in Appendix 5, and there would be a decrease in long-term groundwater availability essentially equivalent to the amount pumped from the overdrafted aquifers. The wide distribution of use suggests that localized water level declines near individual wells or well fields would be negligible.

A reduction in reliance on groundwater by municipalities in the region is the only practical mitigation for the impact. Because plans and schedules for local municipalities switching wholly or partially to surface water sources are not definitive, it is assumed that the impact cannot be effectively mitigated within the time frame of the project. The impact would not be significant because of the wide areal distribution of the increased groundwater use (very limited local effect) and the fact that the major aquifers are already overdrafted and the project-related water use would be a small and very distributed increment to the existing condition.

Groundwater control would be required for construction of building foundations and shafts that would penetrate the glacial and/or upper bedrock aquifer. If dewatering by pumping from well points or wells is employed as the primary control measure, a localized or site level impact may occur. Although the amount of dewatering pumping potentially required cannot be estimated with available data, it is assumed the water levels in nearby wells could be affected by dewatering because of the relative high permeability of the glacial deposits and the upper bedrock aquifer (more pumping required to dewater) and the high density of existing wells in the Illinois site vicinity. To mitigate this potential dewatering impact, Illinois has proposed that the bulk of groundwater control be achieved by use of freezing or slurry wall techniques. These techniques do not involve groundwater withdrawal and result in only negligible disturbance and impact to the local groundwater system. With mitigation, the residual water level/overdraft impacts from shaft and surface facility construction would be negligible.

Available information indicates dewatering would not be employed for tunnel or interaction chamber construction inflow control and there would be no water level/overdraft impact. Based on site-specific hydrogeologic testing, hydraulic conductivity of the Galena-Platteville tunnel unit is typically  $10^{-6}$  cm/s or lower. Groundwater inflows are anticipated to range from essentially zero to perhaps 10 gal/min/100 ft with the lower part of the range prevalent (based on regional tunneling and mining experience). This amount of inflow would have a negligible effect on local groundwater levels. A limited number of fractures may be encountered during tunnel construction that yield a slightly higher inflow. These zones would be grouted or lined to control the inflow as rapidly as practical, again resulting in a negligible effect on water levels in the local groundwater system.

## 2. Recharge

Recharge impacts would be negligible. The total amount of land to be obtained is approximately 16,000 acres or 25 mi<sup>2</sup>. It is estimated that in Illinois less than 4 percent of this area or slightly less than 1 mi<sup>2</sup> would be disturbed by construction or have facilities constructed on it that could impede recharge. Assuming an average recharge rate of 250 acre-ft/yr/mi<sup>2</sup>, recharge to the glacial deposits in Kane and western DuPage counties is on the order of 150,000 acre-ft/yr. Applying this rate to the total disturbed area suggests that recharge could be reduced a maximum of 250 acre-ft/yr, which is substantially less than 1 percent of total estimated recharge to the surficial glacial deposits in the project vicinity, and a very small percentage of recharge in the region. The impact to recharge would continue to be negligible through project operations since there would be minimal, if any, further land surface disturbance or construction of impervious surfaces. Landscaped portions of site facilities may allow recharge at approximately predisturbance or natural rates.

## 3. Subsidence

There would be no subsidence impacts caused by construction or operations groundwater withdrawals. The subsurface stratigraphy at the Illinois site (a sedimentary rock sequence of dolomites, shales, sandstones, and limestones beneath a thin glacial deposit overburden) is not prone to the occurrence of subsidence even under groundwater overdraft conditions.

## 4. Water Quality

Groundwater quality impacts from surface and subsurface construction would be negligible. Groundwater quality is generally good, but locally selected constituents, notably TDS, sulfate, and iron, exceed Federal drinking water standards. Because of the very shallow depth to water typical of the area, minor and very localized water quality effects from surface disturbance, equipment operation, and minor leaks and spills of construction materials are inevitable. These would be minimized by

proper construction practices and use of standard industry procedures for spill and leak response and cleanup. No nonstandard construction practices or materials are planned that would require special procedures to maintain groundwater quality.

Subsurface construction would occur within the glacial and upper bedrock aquifer (shafts) and the Galena-Platteville group (tunnel). Shaft construction and installation of concrete or steel liners would result in a negligible impact to groundwater quality in the immediate vicinity of the shafts. Physical disturbance and the introduction of concrete or metal structures into an aquifer affects only TDS and the common ions such as sulfate, sodium, and calcium. Constituents commonly viewed as contaminants would not be anticipated in measurable amounts if standard practices, such as removing oily coatings from liner materials before installation, are followed. Any changes in groundwater quality would be very localized and, while changes may be locally measurable, there should be no change in potential use of the groundwater.

Water quality impacts from tunnel construction would be negligible. The permeability of the rock at tunnel level is in general very low ( $\approx 10^{-6}$  cm/s) and flow would be toward rather than away from the tunnel. Grout or lining material placed in the tunnel would not be notable sources of contaminants. No special materials or construction practices are anticipated that would be sources of specific contaminants. Petroleum-based contaminants from the TBMs and other construction equipment would occur but groundwater contamination or subsequent migration away from the tunnel would be almost nonexistent because of the near-tunnel hydrogeologic conditions mentioned above.

Handling and disposal of wastewater derived from dewatering or construction sump pumping from shaft and tunnel construction, spoils from shaft and tunnel excavation, and solid wastes from construction are described in detail in Appendix 10. These materials and activities would have a negligible impact on groundwater quality at the site or in the site vicinity. Although the amount of dewatering and sump water cannot be estimated with available data, it is planned to store the water in retention ponds near the service areas. None of the actions would measurably affect groundwater quality since quality in hydrogeologic units down to and including the Cambrian-Ordovician aquifer below the tunnel unit is very similar (Volume IV, Appendix 5, Table 5.3.2-5).

It is anticipated that approximately 3 million yd<sup>3</sup> of spoils would be generated from shafts and the tunnel at the Illinois site. Following temporary near-shaft stockpiling, it is planned to transport the material to four local quarries where it would be blended with quarry product rock and sold for local construction use. Given that the spoils would only be in surface piles for a relatively short time, measurable leachate and degradation of the quality of underlying groundwater is not anticipated. In addition, leachate test results from the Galena-Platteville tunnel unit did not suggest significant leachate generation even from pyrite, which exists in the unit.



It is presently planned that solid waste generated during construction and operations would be transported to two existing permitted landfills in the vicinity of the site. Since these disposals would be to existing landfills it is assumed that controls to local groundwater quality are in place and that disposal of project waste would have no incremental effect on potential groundwater contamination from the landfills.

No groundwater quality impacts related to construction or operations groundwater use are anticipated. The only poor-quality groundwater in the site vicinity is in the deeper portions of the basal bedrock aquifer, which is not proposed as a direct groundwater supply source. Several communities in counties with potential indirect water use do utilize groundwater from the basal bedrock aquifer. While increased groundwater pumpage could induce upward migration of the deeper, poor-quality water, the hydrologic system (including quality of the deeper waters) is relatively well-defined, and it is assumed that any such impact would be avoided by modification of pumping patterns or increased reliance on other aquifers or surface water if available.

#### 5. Public Water Supply Systems

Estimated off-site rural and municipal water uses associated with the project in Illinois are summarized in Table 7-4 (Section 7.1.3.3). The impact to existing public water supply systems from the SSC site-related demand imposed during construction and operations would be negligible. The potential increase in off-site water use during construction is projected to range from 125 acre-ft in 1989 to 825 acre-ft in 1992. Estimated indirect water use during operations is estimated to range from about 500 to 700 acre-ft/yr. This use would be distributed within nine counties around the proposed site, although the majority of the use would occur in Kane, DuPage, and Cook counties. There are well in excess of 100 municipal supply systems within this area. In 1985, the municipal supply use in Kane and DuPage counties alone was approximately 150,000 acre-ft. Water supply systems for the nearby communities of Aurora, Oswego, South Elgin, St. Charles, Warrenville, and West Chicago supplied a total of 41,734 acre-ft of water for residential, commercial, and industrial uses during 1987 (Visocky 1988). The amount of excess capacity available in existing systems is not defined. However, even assuming that all of the increased use is imposed on municipal supply systems, distribution of the projected increase over the number of municipal supply systems involved supports an assumption of a negligible impact to any individual system.

#### 6. Wells

The impact of administrative (land acquisition) or safety related (nearness to tunnel - within 150-ft radius) well closures related to construction at the SSC site in Illinois would be measurable at site level. On the order of 1,500 wells are estimated to exist within 0.25 mi of the proposed ring alignment. Well in excess of 320 wells are believed to be located within the SSC footprint. One or two of these may be municipal supply wells. Only a small number of these wells may

be directly affected and required to be abandoned because of the project. The State estimates that 6 to 31 wells would be potentially closed due to proximity to the tunnel. No estimate of the number of wells within the SSC facility area is available at this time. Even the 6 to 31 wells would be a measurable impact on local water users and water use patterns. Well closures would be a minor beneficial impact for the local groundwater system.

The impact to water users can be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better water quality are provided to affected well owners. The State has indicated it will provide this mitigation. Even assuming this mitigation, there would still be a measurable, site level, and irreversible impact to some number of local groundwater users. The impact would be significant assuming that a number of wells and well users would be affected with a consequent change in the local groundwater use pattern. It is noted that the significance and magnitude of this impact may change as well records and criteria for well closure are further defined.

## B. Operations

### 1. Water Levels/Overdraft

Proposed water supply sources to meet on-site or direct potable and industrial water requirements are as identified in the preceding discussion of construction impacts. However, the projected annual on-site water use is higher and water levels/overdraft impacts during operations would be measurable. As shown in Table 7-1, the annual total projected water use for operations is about 2,175 acre-ft. This use would be distributed throughout the proposed SSC site area and would be derived from multiple aquifer units as described in the construction discussion. However, the greater pumpage required (especially in the vicinity of the proposed campus area at Fermilab where an equivalent continuous pumping rate of about 1,050 gal/min is required) may result in water level declines in nearby wells of sufficient magnitude to locally reduce groundwater availability or modify water use patterns. Localized overdraft of the upper bedrock and Cambrian-Ordovician aquifers would also be increased. As noted previously, present use in the site area from both the upper bedrock and the Cambrian-Ordovician aquifers is on the order of 55,000 acre-ft/yr. While the proposed use is only on the order of a 2 percent increase in use, in an overdraft situation this may require some local adjustments in water use patterns.

Three mitigations are possible for this water level/overdraft impact. First, water use on site could be reduced through reuse, modifications to planned cooling systems, or other approaches. Secondly, surface water from the Fox River is a potential alternative supply source for industrial cooling water at the campus area. Since cooling water constitutes approximately 60 percent of direct operations use, this would substantially reduce the magnitude of groundwater impact. A third potential mitigation is a reduction in local groundwater use when

selected municipal supply systems convert from groundwater to surface water derived from Lake Michigan or other local sources. Such conversions are planned although specific communities and schedules are not finalized.

Since plans and schedules are not finalized, it would be inappropriate to assume the latter mitigation. Implementation of the first two mitigations could potentially reduce annual groundwater use to perhaps 400 to 800 acre-ft/yr. Given the existing local overdraft of the proposed supply aquifers, this level of withdrawal would still suggest a measurable site level, long-term impact.

Part of the groundwater currently being used by the Fermilab could eventually supply the SSC. This would reduce the incremental on-site water need for SSC operations at the proposed Illinois site. However, as it is planned that Fermilab operations will continue at about their present level, the potential transfer of water may be small.

Water level/overdraft impacts from indirect water use during operations was previously assessed (see Section 7.2.3.3.A.1, Construction - Water Levels/Overdraft) as measurable at the regional level and long term.

There would be no water level/overdraft impacts related to groundwater inflow control for the tunnel during operations. Any areas of significant water inflow to the tunnel would be grouted or otherwise controlled during construction. Uncontrolled groundwater inflow to the tunnel would probably be only on the order of a few to a few tens of gal/min/mi and would be too small to have any effect on the surrounding groundwater system.

## 2. Water Quality

Groundwater quality impacts from all aspects of operations would be negligible. Minor and very localized effects to groundwater quality from surface sources are inevitable given the generally shallow water table and normal aspects of human use associated with the project. These negligible impacts would result from activities such as irrigation and fertilization of site landscaping, vehicle use, and snow and ice control during winter. Given the general quality of existing shallow groundwater (Appendix 5, Table 5.3.2-5), these types of sources would not substantially degrade existing conditions.

Chemicals and any other materials with significant contamination potential that are stored on site during operations would be strictly controlled. Procedures would be in place to rapidly respond to and clean up any spills or accidental releases of such material.

Impacts to groundwater quality from subsurface activities would also be negligible. There would be limited materials in the tunnel/shaft environment with a potential to contaminate groundwater, and strict control

procedures would be in place. The tunnel rock unit (Galena-Platteville group) as described previously has a generally low hydraulic conductivity and migration of any contaminants introduced to the groundwater would be limited.

Handling and disposal of sewage and cooling tower blowdown generated during operations are described in detail in Appendix 10. Planned disposal of both would have a negligible impact on groundwater quality. Sewage and cooling tower blowdown from the main campus area would be piped to the existing wastewater treatment plant at Batavia. This plant discharges to surface streams. Sewage from the far cluster would be treated at a new treatment plant to be built near Welch Creek. The plant would have multicell oxidation lagoons and a polishing lagoon with final discharge to Welch Creek. Assuming standard construction of the plant and lagoons, negligible local groundwater quality degradation would be anticipated from such a facility. Sewage at remote service areas would be treated by septic tanks and leach fields. This method of sewage treatment and disposal always has a potential for measurable degradation of shallow groundwater quality on a very localized scale. Assuming that proper siting of the facilities within the surficial glacial deposits would occur, and given the level and range of existing shallow groundwater quality, only a negligible impact is anticipated.

Cooling tower blowdown from remote areas would be disposed of by vacuum compression brine concentrators or side stream softeners and transport to sewage treatment plants. Either option would result in a negligible impact to groundwater quality. Groundwater quality impacts from direct and indirect groundwater use, spoils disposal, and solid waste disposal during operations was previously assessed (see Section 7.2.3.3.A.4, Construction - Water Quality) as negligible.

#### 7.2.3.4 Michigan

##### A. Construction

##### 1. Water Levels/Overdraft

Groundwater is the proposed water supply source for all direct SSC water requirements in Michigan. Groundwater sources are proposed as follows:

- o Main campus and associated experimental and service areas - Wells in Saginaw and/or Marshall formations; involves expansion of existing well field (presently two wells) for the village of Stockbridge. Four to six new wells in the area between Stockbridge and the campus are anticipated.
- o Far cluster and all service areas (F1 through F8) - Well field or single wells in the immediate vicinity of each site tapping the glacial drift, Saginaw formation, or Marshall formation.

General locations of the above areas where groundwater would be developed can be identified on Figure 7-8. The proposed sources include all major aquifer units in the Michigan site vicinity. Proposed withdrawal sites are areally distributed within the site vicinity.

Groundwater resources are readily available at the Michigan site. Available data suggest that recharge to the Saginaw formation significantly exceeds groundwater withdrawals in the region. Groundwater storage in this formation in Ingham and Jackson counties may exceed 18 million acre-ft and recharge may exceed 171,000 acre-ft per year. Sustained yield for the this aquifer is estimated to be on the order of 130 to 260 acre-ft/mi<sup>2</sup>/yr, based on estimates of sustained yield made for the tri-county region. For the two-county area the total sustained yield is estimated to be 164,000 to 328,000 acre-ft/yr. Large, but unquantified, volumes of groundwater are also present in the glacial deposits in this area and in the underlying Marshall formation (Heinzman 1988, and Shirey 1988).

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of in-migration of construction workers and operations personnel and their dependents. This estimated water use is shown in Table 7-5. It varies from 86 acre-ft in 1989 to a high of 675 acre-ft in 1992 and totals 3,551 acre-ft for the planned 7-yr construction period. Operations indirect water use is anticipated to range from about 420 to 530 acre-ft/yr. Most of the increased water use would occur in communities and rural areas in Ingham, Jackson, and Washtenaw Counties; minor increases are projected in seven other counties surrounding the site (Calhoun, Eaton, Hillsdale, Lenawee, Livingston, Shiawassee, and Wayne). Most of the communities and rural users in these counties derive their water supply from groundwater. Communities to the east, such as Ann Arbor and the Detroit area, rely on surface water for all or a major part of their supply.

Water level/overdraft impacts from direct construction water withdrawals would be negligible. The annual amount of estimated construction water use for the SSC project is summarized in Table 7-1. The limited total amount of pumpage required would be distributed around the ring area and between the three local aquifer units. Anticipated total water requirement during the peak year of construction, 1992 (Table 7-1), is equivalent to a continuous pumping rate of just over 50 gal/min. Since this use would be distributed about the SSC site, water level declines, even near individual supply wells would be minimal, probably on the order of a few to a few tens of feet near and at individual pumping wells. The anticipated magnitude of very localized and transient water level declines would not affect groundwater availability or groundwater-use patterns. The amount of groundwater use anticipated would not result in a regional or localized overdraft condition. However, areal recharge and total groundwater-use data are not available to assess the potential for overdraft. Localized overdraft is known to occur around the cities of Lansing and Jackson but is not apparent elsewhere in the site vicinity (Vanlier et al. 1973). Comparison of the generalized estimate of recharge to shallow aquifers (100 acre-ft/mi<sup>2</sup>/yr) with the available partial estimates of groundwater use shown in Appendix 5, Table 5.4.2-7, and estimated direct project use suggest that overdraft would not be initiated.

Water level/overdraft impacts from indirect project water use during construction and continuing through operations would be measurable at the regional level and long term. The increased use would be distributed over a 10-county area within which recent (1984) municipal groundwater use was about 100,000 acre-ft. However, it is logical to assume that a significant portion of the projected use would occur in the communities of Lansing and Jackson, the two largest communities near the site. These two communities are also the only areas where localized groundwater overdraft is documented by areal declines in water levels (Vanlier et al. 1973). Increased groundwater withdrawals related to indirect project use would slightly increase the existing areal water level decline and overdraft. A comparable impact to groundwater is not anticipated in the vicinity of any other potentially affected communities; however, data for evaluation are limited. There are no easily developed alternative supply sources nor plans for development for either of the communities most affected. Consequently it is assumed that the impact cannot be effectively mitigated within the time frame of the project. The impact would not be significant because the incremental use related to the project is very small in relation to present use in the two most affected communities (maximum of 100 to 250 acre-ft/yr versus 1984 usage of about 11,000 and 38,000 acre-ft for the Lansing and Jackson areas respectively) (Huffman 1985).

Groundwater control would be required for construction of building foundations and shafts that would penetrate the glacial deposit and/or the Saginaw Formation. If dewatering by pumping from well points or wells is employed as the primary control measure, a localized or site level short-term impact may occur. Although the amount of dewatering pumping potentially required cannot be estimated with available data, it

is assumed the water level in nearby wells could be affected by dewatering because of the relative high permeability of the glacial deposits and the Saginaw formation (more pumping required to dewater) and the moderate density of existing wells in the site vicinity. To mitigate this potential dewatering impact, Michigan has proposed that the bulk of groundwater control would be achieved by freezing or slurry wall techniques. Where dewatering pumping is necessary, they have proposed re-injection of dewatering effluent. With these mitigation measures, the residual water level overdraft impact from shaft and surface facility construction would be negligible.

Water level/overdraft impacts from tunnel construction would be negligible, because dewatering is not the primary groundwater control measure. Initial groundwater inflow is anticipated along the entire tunnel length to be predominantly on the order of <1 to 20 gal/min/100 ft, with higher inflows in more permeable sandstone zones and along more transmissive joints. A low-head liner is planned for the tunnel which will provide a seal with no residual inflow. Grouting techniques would be utilized initially in areas of significant inflow.

## 2. Recharge

Recharge impacts would be negligible. Recharge to the shallow glacial aquifer and the underlying Saginaw and Michigan formations occurs throughout the site vicinity. However, based on the description of project facilities and construction in Appendix 1, only about 1 to 2 mi<sup>2</sup> of land would be disturbed by construction or have project facilities constructed on it that could impede recharge. Recharge to shallow groundwater in the glacial deposits is estimated to be on the order of 100 acre-ft/yr/mi<sup>2</sup> (Vanlier et al. 1973). Applying this rate to the total disturbed area suggests that recharge would be reduced a maximum of 100 to 200 acre-ft/yr. Since it is unlikely that recharge would be totally eliminated in all areas of project construction or land disturbance, the actual reduction in recharge should be substantially less.

The impact to recharge would continue to be negligible through operations since there would be minimal, if any, further land surface disturbance or construction of impervious surfaces. Landscaped portions of project facilities may allow recharge at approximately predisturbance or natural rates.

## 3. Subsidence

There would be no subsidence impacts caused by construction or continuing operations groundwater withdrawals. The subsurface stratigraphy at the Michigan site, a sedimentary rock sequence of dolomites, shales, sandstones, and limestones beneath a thin glacial overburden, is not prone to subsidence even under localized groundwater overdraft conditions.

#### 4. Water Quality

Groundwater quality impacts from surface and subsurface construction and groundwater use associated with construction would be negligible. This assessment is based on the fact that only standard construction materials and procedures would be employed. Site groundwaters are characterized by moderate levels of dissolved solutes (Appendix 5, Table 5.4.2-6), and therefore are not highly sensitive to minor changes in common dissolved constituents. Also, there are selected constituents in site groundwaters, notably TDS, chloride, and iron, that locally exceed Federal drinking water standards.

Because of the very shallow depth to water typical of the area, minor and very localized water quality effects from surface disturbance, equipment operation, and minor leaks and spills of construction materials are inevitable. These would be minimized by good construction practices and use of standard industry procedures for spill and leak response and cleanup. In addition, the clay-rich soil typical of the glacial terrain in Michigan should help to minimize infiltration of any surface-derived contaminants. No nonstandard construction practices or materials are planned that would require special procedures to maintain groundwater quality.

Subsurface construction would occur within the glacial, Saginaw, and Marshall aquifers. Shaft construction and installation of concrete or steel liners would result in a negligible impact to groundwater quality in the immediate vicinity of the shafts. Physical disturbance of aquifer material and the introduction of concrete or metal structures into an aquifer affects only TDS and the common ions such as sulfate, sodium, calcium, and iron. Constituents commonly viewed as contaminants would not be anticipated in measurable amounts from these activities if standard practices, such as removing oily coatings from liner sections before installation, are followed. Any changes in groundwater quality would be very localized and, while changes may be locally measurable, there should be no change in potential use of the groundwater.

Water quality impacts from tunnel construction would be negligible. The permeability of the rock at tunnel level is variable ( $10^{-2}$  to  $10^{-7}$  cm/s) and contaminant migration could occur in more permeable zones. However, flow gradients would generally be toward rather than away from the tunnel and the more permeable zones would likely be grouted or otherwise sealed to minimize tunnel inflow. Any grout material placed in the tunnel would not be a notable source of contaminants. No special materials or construction practices are anticipated that would be sources of specific contaminants. Petroleum-based contaminants from the TBMs and other construction equipment would occur, but groundwater contamination or subsequent migration away from the tunnel would be negligible, if any, because of the groundwater flow pattern around the tunnel. Following initial boring and grouting, the tunnel would be lined and there would be no further interaction between groundwater and the tunnel environment.



Handling and disposal of wastewater derived from dewatering or construction sump pumping from shaft and tunnel construction, spoils from shaft, and tunnel excavation and solid wastes from construction are described in detail in Appendix 10. These materials and activities would have a negligible impact on groundwater quality. Although the amount of dewatering and sump water cannot be accurately estimated with available data, it is planned to treat the water with carbon filters and then reinject to the groundwater system. The water could also be stored in temporary ponds near the service areas and used for selected construction uses, e.g., dust control. None of the storage, use, or disposal options would measurably affect groundwater quality since the water quality in all hydrogeologic units, down to and including the Marshall formation, is quite similar (Appendix 5, Table 5.4.2-6). Any measurable contaminants in sump water, such as oil and grease from the TBMs or other equipment, would be removed by treatment prior to reinjection or transfer to temporary storage ponds. Reinjection should, however, be restricted to the unit of withdrawal to minimize water quality concerns. In addition, injection would have to be at a sufficient distance down-gradient from the tunnel to preclude modifying flow gradients and inducing tunnel inflow.

It is anticipated that approximately 2.6 million yd<sup>3</sup> of spoils would be generated from shafts and the tunnel at the Michigan site. The material would be approximately 80 to 95 percent sandstone and limestone and 5 to 15 percent shale, coal, and gypsum with some potential for leachate generation. Following temporary near-shaft stockpiling, it is planned to transport the sandstone and limestone to nearby operating quarries for stockpiling and use by blending with quarry materials. The fact that stockpiling would be temporary and that the material has minimal leachables suggests there would be no impact to groundwaters underlying the temporary stockpiles at either the shaft sites or the quarries. The shale, coal, and gypsum materials with leachate generation potential may be treated on-site (fixated) prior to use or disposal, or may be disposed of in licensed Class II or III landfills. Either option would preclude any groundwater contamination potential.

It is presently planned that solid waste generated during construction and subsequent operations would be transported to existing licensed landfills (four are available) in the project vicinity. Since this disposal would be to existing landfills it is assumed that controls to protect local groundwater quality are in place, and that disposal of project waste would have little if any incremental effect on potential groundwater contamination from the landfills.

No groundwater quality impacts related to construction or continuing operations groundwater use are anticipated. There are areas of high salinity water known in the Marshall formation and high chloride water is locally encountered at depth in the Saginaw formation. Location of these occurrences of poor-quality water are relatively well-defined and can be avoided during siting of wells for direct project water use.

Increased pumpage of groundwater for indirect project water use at area communities could induce migration of poor quality groundwater toward municipal supply wells. The apparent limited increase in pumpage at any individual community (Table 7-5) suggests that such an impact would not result because of project-related increased pumping.

#### 5. Public Water Supply Systems

The estimated off-site rural and municipal water use associated with the project is summarized in Table 7-5. The impact to existing public water supply systems from the project-related demand imposed during construction and subsequent operations would be negligible for larger communities such as Lansing, Ann Arbor, and Jackson, but would be measurable at the site level and long-term for many of the smaller communities in Ingham, Jackson, and other surrounding counties.

The potential increase in off-site water use is projected to range from about 85 acre-ft in 1989 to a high during construction of about 675 acre-ft in 1992. Estimated indirect water use during operations is estimated to range from about 420 to 530 acre-ft/yr. This use would be distributed within 10 counties around the proposed site where most of the communities rely on groundwater for municipal supply. The majority of the use would occur in Ingham, Jackson, and Washtenaw counties and presumably in the communities of Lansing, Jackson, and Ann Arbor. Although the amount of excess capacity available in these community systems is not defined by available data, the systems are relatively large (Huffman 1985) and the incremental use, which should be only on the order of 50 to perhaps 150 acre-ft/yr, should result in only a negligible impact or requirement for system expansion.

Many of the smaller communities in the affected counties (such as Stockbridge, Mason, and Leslie) have municipal systems supplied by a very small number of wells and any substantial expansion may require an additional well(s) as well as expanded treatment and/or distribution capacity.

#### 6. Wells

The impact of administrative (land acquisition) or safety-related (nearness to tunnel - within 150 ft radius) well closures would be measurable at the site level. No record search or survey has been performed to estimate the number of wells within 0.50 or 0.25 mi of the proposed tunnel alignment. In excess of 100 wells are probably located within the SSC footprint. Review of 1968-1970 records from the Ingham and Jackson county health departments indicates approximately 80 wells within the footprint. Although only a small portion of these wells may be directly affected and require abandonment because of the project, a number may still be so impacted. This would be a measurable impact on water users and local water use patterns. Well closures would be a minor beneficial long-term impact for the local groundwater system.

The impact to water users can be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better quality are provided to affected well owners. The State has indicated it will provide this mitigation. Even assuming this mitigation, there would still be a measurable, site level and irreversible impact to local groundwater users. The impact would be significant assuming that a number of wells and well users would be affected with a consequent change in the local groundwater use pattern. It is noted that the significance and magnitude of this impact may change as well records and criteria for well closure are further defined.

## B. Operations

### 1. Water Levels/Overdraft

Proposed water supply sources to meet on-site or direct potable and industrial water requirements are as identified in the preceding discussion of construction impacts. However, the projected annual on-site water use for operations is higher, and water level/overdraft impacts during operations would be measurable at the site level and long-term.

As shown in Table 7-1, the annual total projected water use for operations use is about 2,175 acre-ft. This use would be distributed throughout the proposed site area and would draw from the two major local aquifer units. Water level/overdraft impacts at the far cluster and individual service areas would be negligible because of limited water requirements (equivalent continuous pumping rates of 85 and 50 gal/min, respectively). However, the greater pumpage required in the vicinity of the proposed campus area, where an equivalent continuous pumping rate of about 860 gal/min is required, may result in water level declines of sufficient magnitude to affect supply availability on local water use patterns. The density of existing well distribution near Stockbridge is sufficient that the probability of affecting water levels at existing wells is high.

There is no present regional overdraft in the immediate Michigan site vicinity. The proposed use would result in localized overdrafting in the vicinity of Stockbridge where pumpage for municipal supply in 1984 was only 170 acre-ft. The annual recharge to the Saginaw Formation, the probable supply aquifer, can be assumed to be substantially less than the 100 acre-ft/mi<sup>2</sup>/yr estimated for the overlying glacial deposits (Vanlier et al., 1973). There would be a measurable impact since changes in existing groundwater use patterns may be required to accommodate the expanded use for the SSC site in the Stockbridge vicinity.

There are limited mitigation options available for water level overdraft impacts. While surface water is relatively plentiful as an alternative supply source, there is no history of use or existing infrastructure for use in the immediate site vicinity. Proposing surface water as an alternative may not be practical. Site water supply wells can be carefully located in relation to existing wells to minimize water level impacts, and site water use can be minimized to the extent practical through

reuse or other means. However, assuming that there are no totally effective mitigations, the water level decline/overdraft impacts would remain measurable. Regionally the impacts would not be significant since the changes in the water use patterns that may result would be very localized and may affect only the Stockbridge area.

Water level/overdraft impacts from indirect SSC site water use during operations was previously assessed (see Section 7.2.3.4.A.1, Construction - Water Level/Overdraft) as measurable at the regional level and long term.

There would be no water level/overdraft impacts related to groundwater inflow control for the tunnel during operations. Any areas of significant water inflow to the tunnel would be grouted or otherwise controlled during construction. The tunnel would be lined and there would be little if any residual inflow.

## 2. Water Quality

Groundwater quality impacts from all aspects of operations would be negligible.

Minor and very localized effects on groundwater quality from surface sources are inevitable given the generally shallow water table and normal aspects of human use associated with the project. These negligible impacts would result from activities such as irrigation and fertilization of site landscaping, vehicle use, and snow and ice control during the winter. Given the general quality of existing shallow groundwater (Appendix 5, Table 5.4.2-6), these types of sources should not measurably degrade existing conditions. In addition, the clay-rich soil or subsoil typical of the glacial terrain in Michigan should help to minimize infiltration of any surface-derived contaminants.

Chemicals and other materials with significant contamination potential stored on site for operations would be strictly controlled and procedures would be in place to rapidly respond to and clean up any spills or accidental releases of such material.

Impacts to groundwater quality from subsurface activities would also be negligible. There would be limited materials in the tunnel/shaft environment with a potential to contaminate groundwater and strict control procedures would be in place. The tunnel rock units, however, have variable hydraulic conductivity, and migration of any contaminants that might be introduced to groundwater is possible. The low head liner and grouting of permeable zones in the tunnel would limit the potential for initial contamination of groundwater. Additionally, any wells within a 150-ft radius of the tunnel would have been abandoned and closed during construction.

Handling and disposal of sewage and cooling tower blowdown generated during operations are described in detail in Appendix 10. Planned options for disposal of both would have only a negligible impact on groundwater quality. Sewage from the campus area would be treated at the Stockbridge facility which would be upgraded. This would be a permitted, standard sewage treatment facility and negligible local groundwater quality degradation would be anticipated. Domestic sewage at the experimental and remote service areas would be treated by septic tanks with disposal by land application or leach fields. These methods of treated sewage disposal always have a potential for measurable degradation of shallow groundwater quality on a very localized scale. However, assuming that permitting and proper siting of disposal sites within the surficial glacial deposits would occur, only a negligible impact is anticipated.

Cooling tower blowdown would be disposed of by vacuum compression brine concentration units or side stream softeners. Either option would result in a negligible impact to groundwater quality.

Groundwater quality impacts from direct and indirect groundwater use and solid waste disposal during operations were previously assessed as negligible (see Section 7.2.3.4.A.4, Construction - Water Quality).

### 7.2.3.5 North Carolina

#### A. Construction

##### 1. Water Levels/Overdraft

Surface water is the proposed water supply source for the majority of direct SSC water requirements in North Carolina. Groundwater is proposed to supply only the eight remote service areas (F1 through F4; F6 through F9) via single wells in the immediate vicinity of each site tapping saprolite and/or the upper weathered and fractured bedrock. General locations of the service areas where groundwater may be developed can be identified on Figure 7-9.

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of in-migration of construction workers and operations personnel and their dependents. This estimated water use is shown in Table 7-6. It varies from 300 acre-ft in 1989 to almost 1,900 acre-ft in 1992 and totals about 9,650 acre-ft for the planned 7-yr construction period. Operations indirect water use is anticipated to range from 1,195 to 1,595 acre-ft/yr. Most of the increased water use would occur in communities and rural areas in Durham, Person, and Granville counties; minor increases are projected in 17 other counties in North Carolina and Virginia. Most of the communities in this area derive their water supply almost exclusively from surface water. Rural water supplies are typically derived from groundwater. Rural indirect water use related to the project would be 10 percent or less of the projected total.

Water level/overdraft impacts from direct construction water withdrawals would be negligible. Groundwater use would occur only at the remote service areas. Annual water use at each well would probably occur only during active construction at the individual service areas and would likely be less than 10 acre-ft during this period. This suggests a full-time equivalent pumping rate on the order of 10 or less gal/min. With pumping of this magnitude there should be no measurable water level declines at distances of a few hundred feet from the pumping wells. Estimates of safe yields for surficial aquifers in the area range from 5 to 29 acre-ft/yr/mi<sup>2</sup> and are based on low flow measurements at selected gaging stations in the vicinity of the site (Sutherland 1988). Thus, the small (probably less than 20 acre-ft/yr) amount of groundwater use anticipated would not result in a regional or localized overdraft condition.

Water level/overdraft impacts from indirect project water use during construction and continuing through operations would be negligible. Groundwater use would be primarily, if not exclusively, for rural domestic supply. Assuming as stated previously that groundwater would supply less than 5 percent of projected indirect water use suggests annual groundwater pumpage of 30 to a maximum of 200 acre-ft distributed over 20 counties in North Carolina and Virginia. Domestic water supply

wells typically only require pumping capacities of 5 to 10 gal/min and measurable water level declines are typically not observed at distances of more than a few hundred feet from such wells. No localized or regional overdraft would result from such minimal and distributed groundwater use.

At the North Carolina site some groundwater control would be required for construction of building foundations, the booster/injector complex, and shafts that would penetrate the saprolite and weathered bedrock. If dewatering by pumping from well points or wells is employed extensively a measurable site level short-term impact may occur. Although the amount of dewatering pumping potentially required cannot be estimated with available data, water levels in nearby wells could be affected because of the tendency for hydrogeologic interconnection over distance in a fractured rock regime. To mitigate this potential dewatering impact, groundwater control would also be achieved by freezing or slurry wall techniques and by grouting. If dewatering pumping is minimized, the residual water level/overdraft impact would be negligible.

Dewatering is only planned as an alternative or intermittent groundwater control measure for tunnel construction, and consequently water level/overdraft impacts from tunnel construction would be negligible. Initial groundwater inflow is anticipated to be predominantly on the order of <5 to several tens of gal/min/100 ft. Elevated inflows may be encountered at intermittent fracture zones. Grouting techniques would be utilized in areas of more significant inflow, while sumps would remove residual and diffuse inflow water from the tunnel. The amount of residual uncontrolled inflow, although not quantified, would result in only a negligible, if any, impact to water levels in the local groundwater system.

## 2. Recharge

Recharge impacts caused by construction activities would be negligible. Recharge to the saprolite and the weathered/fractured bedrock aquifer occurs throughout the North Carolina site vicinity. No recharge data were available, however it is logical to assume that the safe yield estimate of 5 to 29 acre-ft/yr/mi<sup>2</sup> is an approximation of recharge (Rima 1988). Based on the description of project facilities and construction in Appendix 1, only about 3 mi<sup>2</sup> of land would be disturbed by construction or would have project facilities built on it that could impede recharge. Since it is unlikely that recharge would be totally eliminated in all areas of project construction or land disturbance, the actual reduction in site vicinity recharge would be very small.

The impact to recharge would continue to be negligible through project operations since there would be minimal, if any, further land surface disturbance or construction of impervious surfaces. Landscaped portions of project facilities may allow recharge at approximately predisturbance or natural rates.

### 3. Subsidence

There would be no subsidence impacts caused by construction or continuing operations groundwater withdrawals. The subsurface stratigraphy, a thin veneer of weathered bedrock overlying a complex sequence of igneous and metamorphic rocks, is not prone to subsidence even if groundwater use were significant.

### 4. Water Quality

Groundwater quality impacts from surface and subsurface construction and the minor groundwater use associated with construction would be negligible. The assessment is based on the fact that only standard construction materials and procedures would be employed and that site groundwaters are already characterized by a range of low to moderate levels of dissolved solutes (Appendix 5, Table 5.5.2-6) and therefore are not highly sensitive to minor changes in common dissolved constituents.

Because of the generally shallow depth to water typical of the area, minor and very localized water quality effects from surface disturbance, equipment operation, and minor leaks and spills of construction materials are inevitable. These would be minimized by proper construction practices and use of normal industrial procedures for spill and leak response and cleanup. In addition, the clay-rich saprolite typical of the North Carolina site should help to minimize infiltration of any surface derived contaminants. Standard construction practices and materials are planned that would not require special procedures to maintain groundwater quality.

Subsurface construction would occur within the saprolite and upper weathered/fractured bedrock aquifer. Shaft construction and installation of concrete or steel liners would result in a negligible impact of groundwater quality in the vicinity of the shafts. Physical disturbance of aquifer material and the introduction of concrete or metal structures into an aquifer affects only TDS and the common ions such as sulfate, sodium, calcium, and iron. Constituents commonly viewed as contaminants would not be anticipated in measurable amounts from these activities if standard practices, such as removing oily coatings from liner sections before installation, are followed. Any changes in groundwater quality would be very localized and, while changes may be locally detectable, there should be no change in potential use of the groundwater.

Water quality impacts from tunnel construction would be negligible. In general, the tunnel is below typical aquifer depth in the area. The permeability of unfractured rock at tunnel level is probably low (assume  $10^{-3}$  to  $10^{-6}$  cm/s), and the potential for contaminant migration is greatest in the vicinity of open fractures that will be occasionally encountered. In general, the local flow gradient in unfractured rock would be toward the tunnel, and fracture zones or single fractures would likely be grouted or otherwise sealed to minimize tunnel inflow. Any grout or lining material placed in the tunnel would not be notable



sources of contaminants. No special materials or construction practices are anticipated that would be sources of special contaminants. Petroleum-based contaminants from the TBMs and other construction equipment would occur, but groundwater contamination or subsequent migration away from the tunnel would be negligible, if any, because of the sealing of fractures and the groundwater flow pattern around the tunnel.

Handling and disposal of wastewater derived from dewatering or construction sump pumping from shaft and tunnel excavation and solid wastes from construction and operations are described in detail in Appendix 10. These materials and activities would have negligible impact on groundwater quality at the North Carolina site.

The amount of dewatering discharge and sump water cannot be accurately estimated with available data. However, it is planned to treat the water as necessary (e.g., separation of oils from tunnel sump water) and then store it in ponds near each shaft location. The water would be used for construction purposes such as dust control or cooling tower makeup. ReInjection to the groundwater would require an Underground Injection Control permit from the EPA (which administers these permits under the Safe Drinking Water Act) and would have to be done in a manner to avoid increasing hydraulic head and therefore inflow to the tunnel. None of the storage, use, or disposal options would measurably affect groundwater quality since shallow groundwater quality and the water quality in all hydrogeologic units down to tunnel depth are basically similar (Appendix 5, Table 5.5.2-6). Any measurable contaminants in sump water such as oil and grease from the TBMs or other equipment would be removed by treatment prior to storage, use, or injection.

It is anticipated that approximately 2.7 million yd<sup>3</sup> of spoils would be generated from shafts and the tunnel at the North Carolina site. The material would be essentially all metasedimentary and metavolcanic rock, which have a limited potential for adverse leachate generation. Following temporary near-shaft stockpiling, it is planned to dispose of the spoils at 17 selected surface disposal sites near shaft locations. At each location a 4- to 5-acre area would be cleared, the spoils piled up to 20 ft deep, and then covered with the native topsoil and revegetated. Given the level of annual precipitation at the site, it is logical to assume that a significant volume of leachate would be generated at each site unless a low permeability cap is placed over each pile. However, since there are limited easily leachable or problem minerals in the spoils, leachate and leachate infiltration to shallow groundwater would not have a measurable impact; groundwater quality would not be altered sufficiently to require a change in potential groundwater use. To minimize the groundwater quality impact potential, the spoils disposal piles could be capped, or an alternative such as using the spoils for construction aggregate materials could be considered.

It is presently planned that solid waste generated during construction and subsequent operations would be transported to existing licensed landfills since there are several with existing capacity within general proximity of the site. Since disposal would be to existing landfills it is assumed that controls to protect local groundwater quality are in place and that disposal of project waste would have little, if any, incremental effect on potential groundwater contamination from the landfills. If the option of a new on-site landfill is selected, it would be permitted and developed and operated to state standards such that only a negligible, if any, impact to groundwater quality would occur.

#### 5. Public Water Supply Systems

The estimated off-site rural and municipal water use associated with the project in North Carolina is summarized in Table 7-6. It was noted in discussion of water level/overdraft impacts that essentially all major municipal supply systems in the site vicinity have a surface water supply source. Rural areas are more likely to use groundwater obtained from individual, privately-owned wells. Consequently, there would be no impact to groundwater-based public water supply systems.

#### 6. Wells

The impact of administrative (land acquisition) or safety-related (nearness to tunnel - within 150-ft radius) well closures would be measurable at the site level. No areal survey has been performed to estimate the total number of wells within 0.50 or 0.25 mi of the proposed tunnel alignment. Only a small number of these wells may be directly affected or require abandonment because of the project. There may be in excess of 200 to 300 wells within the SSC footprint. This would still be a measurable impact on local water users and on local water use patterns. Well closures would be a minor beneficial impact for the local groundwater system.

The impact to water users can be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better quality are provided to affected well owners. The State has indicated it will provide this mitigation. Even assuming this mitigation, there would still be a measurable, site level, and irreversible impact to local groundwater users. The impact would be significant assuming it to be a number of wells and well owners that may be affected. It is noted that the significance and magnitude of this impact may change as well records and criteria for well closure are further defined.

#### B. Operations

##### 1. Water Levels/Overdraft

Proposed water supply sources to meet on-site or direct potable and industrial water requirements are as identified in the preceding discussion of construction impacts. Groundwater is proposed to supply

only the eight remote service areas. Even though projected operations use is slightly higher than during construction, only a negligible water level/overdraft impact is anticipated. As shown in Table 7-1, the annual total projected water use for these service areas is 640 acre-ft, or 80 acre-ft/site/yr. This use is equal to an equivalent continuous pumping rate of about 50 gal/min. Pumping at this rate should not produce water level declines measurable more than a few hundred feet from the pumping well, although in a fracture-dominated system impacts could have greater areal extent depending on fracture interconnection. Assuming normal care and areal reconnaissance in siting project wells, water level decline impacts would be negligible. There is no groundwater overdraft in the North Carolina site vicinity and the magnitude of operations withdrawals is not large enough to initiate localized groundwater overdraft.

There would be no water level/overdraft impacts related to groundwater inflow control for the tunnel during operations. Any areas of significant water inflow to the tunnel would be grouted or otherwise controlled during construction. Uncontrolled groundwater inflow to the tunnel would probably be only on the order of a few to a few tens of gal/min/mi, too low to have any effect on the surrounding groundwater system.

## 2. Water Quality

Groundwater quality impacts from all aspects of operations would be negligible. Minor and very localized effects on groundwater quality from surface sources are inevitable given the generally shallow water table and normal aspects of human use associated with the project. These negligible impacts would result from activities such as irrigation and fertilization of site landscaping, and vehicle use. Given the general quality of existing shallow groundwater (Appendix 5, Table 5.5.2-6), these types of sources should not measurably degrade existing conditions. In addition, the clay-rich soil typical of the site area should help to minimize infiltration of any surface-derived contaminants. Chemicals and other materials stored on site with significant contamination potential would be strictly controlled and procedures would be in place to rapidly respond to and clean up any spills or accidental releases of such material.

Impacts to groundwater quality from subsurface activities would also be negligible. There would be limited materials in the tunnel/shaft environments with a potential to contaminate groundwater, and strict control procedures would be in place for any materials present. The tunnel rock units have very low hydraulic conductivity, except in fractures or fracture zones where migration of any contaminants that might be introduced to groundwater is possible. However, it is likely that all fractures and fracture zones would have been grouted or otherwise sealed to reduce groundwater inflow. This would limit the potential for contamination of groundwater within these more permeable zones.

Handling and disposal of sewage and cooling tower blowdown generated during operations are described in detail in Appendix 10. Planned options for disposal of both would have only a negligible impact on groundwater quality. Domestic sewage from the campus area and southwest quadrant ( $\approx 150,000$  gal/d) would be transported to and treated at the proposed expanded Butner wastewater treatment plant. Use of this existing permitted facility would result in no additional impact to groundwater quality in the site vicinity. Sewage from the southwest quadrant will be treated at the Durham-Eno River treatment facility. Wastewater from the two northern quadrants will be treated at the Oxford-South treatment facility. Sewage from the far cluster and remote service sites will go to the closest wastewater treatment facility or to a package treatment plant constructed for the facility. The use of existing permitted facilities would again result in no additional impact to groundwater quality in the site vicinity. All treatment/disposal facilities would need to be permitted by the county and/or state and an overall negligible impact to site groundwater quality would result.

No specific plans for treatment/disposal of cooling tower blowdown were presented by the State. It is assumed that blowdown will be disposed of by using vacuum compression brine concentrator units or by side stream softening.

Groundwater quality impacts from direct and indirect groundwater use and solid waste disposal during operations were previously assessed as negligible (see Section 7.2.3.5.A.4, Construction - Water Quality).

### 7.2.3.6 Tennessee

#### A. Construction

##### 1. Water Levels/Overdraft

Surface water is the proposed water supply source for the majority of direct SSC water requirements in Tennessee. Surface water from several sources would be provided from existing water utilities to the campus, to far cluster areas, and to all but two of the remote service areas. These two areas, F7 and F8, would be supplied by the College Grove Utility District, which reportedly obtains its water from a single well. F7 and F8 are located along the northwest portion of the ring as it is aligned in Tennessee (Figure 7-10).

During construction and throughout operations, indirect groundwater use would occur in communities and rural areas in the site vicinity because of in-migration of construction workers and operations personnel and their dependents. This estimated water use is shown in Table 7-7. The use varies from 270 acre-ft in 1989 to just over 1,600 acre-ft in 1992 and totals 8,600 acre-ft for the planned 7-yr construction period. Operations indirect water use is anticipated to range from 1,070 to 1,420 acre-ft/yr. Most of the increased water use is projected to occur in communities and rural areas in Rutherford, Marshall, Bedford, and Davidson counties (Figure 7-10); minor increases are projected in 17 other counties in the project vicinity in Tennessee. Almost all the communities in this area of Tennessee derive their municipal supply from surface water. Rural water supplies are typically derived from groundwater. Rural indirect water use related to the project would probably be less than 10 percent of the projected total.

Water level/overdraft impacts from direct construction groundwater withdrawals would be negligible. Groundwater would only be used by the College Grove Utility District to provide construction water to the F7 and F8 sites. Perceptible water use would probably occur only during active construction periods at the two service areas and would likely be less than 10 acre-ft during this period. Assuming that the active construction periods are not totally concurrent, the projected use suggests a full-time equivalent pumping rate of less than 10 gal/min, or about 8,000 gal/d. An approximation of the expected safe yield of the karst aquifers beneath the SSC site is 340 acre-ft/mi<sup>2</sup>/yr, based on recharge to cave systems in the region. This estimate suggests that approximately 100,000 acre-ft of groundwater could be obtained annually from the area within the SSC ring. Quantitative estimates of safe yield from the underlying Knox aquifer are not available but this might be about 20 percent of the safe yield of the karst aquifer (Rima 1988).

The College Grove Utility District is presently operating at slightly more than 50 percent of its capacity with the average water demand being 75,000 gal/d. If an increased 10,000 gal/d (13 percent) demand is placed on the present system, which would approximate potential SSC direct and indirect water use, water levels in the local area around the

well would decline but there should be no measurable water level declines at distances of more than a few hundred feet from the pumping well. The limited amount of groundwater use, probably on the order of only 20 acre-ft for the construction period, would not result in any regional or localized overdraft condition.

Water level/overdraft impacts from indirect project water use during construction and continuing through operations would be negligible. As noted previously, almost all municipal water systems in the project vicinity are supplied by surface water and consequently impacts related to municipal groundwater use would be negligible. Indirect groundwater use would be primarily for rural domestic supply and that use by the College Grove Utility District discussed previously. Assuming, as stated previously, that rural groundwater use would be less than 10 percent of projected indirect water use, then annual groundwater pumpage of 30 to 160 acre-ft would be distributed over 21 counties. Domestic water supply wells typically only require pumping capabilities of 5 to 10 gal/min and measurable water level declines generally are not observed more than a few hundred feet from such wells. No localized or regional overdraft would result from such minimal and distributed groundwater use.

Groundwater control would be required at the Tennessee site for construction of building foundations and shafts that would penetrate carbonate rock units. The primary groundwater inflow control techniques employed in a carbonate rock environment are grouting and slurry walls. Dewatering by pumping is not typically employed because of the tendency for groundwater flow to be channelized in fractures and small- to large-scale dissolution features in the dominant carbonate bedrock. Assuming that dewatering would be used minimally for surface facility and shaft construction, the water level/overdraft impact from this phase of construction would be negligible.

Dewatering pumping would also be used minimally, if at all, during tunnel construction. Groundwater inflow to the tunnel would be predominantly related to the occurrence of dissolution features at depth. Groundwater inflow over most of the tunnel is anticipated to range from zero to a few tens of gal/min/100 ft. This inflow could be managed with sump pumps and would not have a measurable water level/overdraft impact. An unknown number of zones (dissolution features) might be encountered with inflows of higher volumes. The only effective control again would be grouting supplemented perhaps with liners. Use of these techniques to control any large inflows would result in negligible, if any, water level/overdraft impacts to the local groundwater system.

## 2. Recharge

Recharge to the carbonate aquifer units occurs throughout the Tennessee site vicinity. It may be assumed that the estimated safe yield of the shallow limestone or karst aquifer of 340 acre-ft/mi<sup>2</sup>/yr is an approximation of groundwater recharge in the site vicinity. Based on the description of project facilities and construction in Appendix 1, only

slightly more than 2 mi<sup>2</sup> of land would be disturbed by construction and/or would have project facilities built on it that could impede recharge. Since it is unlikely that recharge would be totally eliminated in all areas of project construction or land disturbance, the actual reduction in site vicinity recharge would be quite small.

The impact to recharge would continue to be negligible through project operations since there would be minimal, if any, further land surface disturbance or construction of impervious surfaces. Landscaped portions of project facilities may allow recharge at approximately predisturbance or natural rates.

### 3. Subsidence

There would be no subsidence impact caused by construction or continuing operations groundwater withdrawals. Anticipated groundwater withdrawals would be minimal, and the subsurface stratigraphy at the Tennessee site, essentially a sequence of carbonate rocks with some shale and sandstone, is not prone to the occurrence of subsidence even if groundwater use were large.

### 4. Water Quality

Groundwater quality impacts from surface and subsurface construction and the minor groundwater use associated with construction would range from negligible to measurable. Site groundwaters are already characterized by a wide range and moderately high level of dissolved solutes (Appendix 5, Table 5.6.2-6) and, therefore, are not widely sensitive to minor changes in common dissolved constituents. There are also selected constituents in site groundwater, notably TDS, sulfate, and iron, which locally exceed Federal drinking water standards. However, it is also pertinent to note that the site geologic conditions (thin or no soil cover and carbonate bedrock with moderate to extensive dissolution in the upper 50 to 200 ft) are conducive to contamination of shallow groundwater from surface or near-surface sources. Recent investigations conducted in the vicinity of the proposed SSC campus area (Crawford and Barr 1988) indicate the existence of a quite highly karsted environment in the shallow limestone units. Open karst features through the campus area are suggested based on tracer test results. The existence of 58 known caves in the immediate vicinity of the proposed ring alignment suggests that the karst is extensive and typifies the shallow hydrologic system. Given this condition, the potential for contamination of the shallow groundwater resource which is developed in the area is high. Potential surface sources at the Tennessee site should be closely controlled and monitored to minimize impact to groundwater quality. Plans for control and monitoring of potential sources of groundwater contamination should be developed as a part of final project design.

Because of the relatively shallow depth to water typical of the area and the karst nature of the shallow aquifer system at the Tennessee site, localized and potentially areally extensive groundwater quality effects may result from surface and shallow subsurface disturbance, equipment operation, and minor leaks and spills of construction materials. These impacts would be measurable at the site level. Impacts would not be significant assuming implementation of mitigations including: 1) detailed site investigations to characterize the nature and extent of karst features in the SSC site vicinity; 2) avoidance of major karst features by shallow subsurface construction; 3) strict spill and leak response and cleanup procedures; and 4) monitoring of groundwater in the vicinity of SSC construction. Standard materials are planned for use that would not require special procedures to maintain groundwater quality.

Subsurface construction would occur within carbonate bedrock units, several of which are aquifers in the Tennessee site vicinity. Shaft construction and installation of concrete or steel liners would result in a negligible impact to groundwater quality in the vicinity of the shafts. Physical disturbance of aquifer material and the introduction of concrete or metal structures into an aquifer affects only TDS and the common ions such as sulfate, sodium, calcium, and iron. Any changes in groundwater quality would be localized and, while changes may be locally detectable, there should be no change in potential use of the groundwater.

Groundwater quality impacts from tunnel construction would be negligible. The tunnel would be below the depth of extensive dissolution in the local carbonate bedrock and limited groundwater movement is anticipated in the massive carbonate at tunnel depth. Dissolution features that may be encountered during tunnel construction would be grouted or otherwise sealed to control groundwater inflow and would not provide avenues for groundwater contamination from subsequent construction activities in the tunnel. No specific contaminant source materials are anticipated in the tunnel during construction. Petroleum-based contaminants from the TBMs and other construction equipment would occur, but groundwater contamination and subsequent migration away from the tunnel would be negligible because of the sealing of dissolution features.

Tunnel construction in Tennessee could require temporary but significant groundwater inflow control while dewatering for shaft construction will be minimal.

The amount of shaft dewatering discharge and tunnel sump water cannot be accurately estimated with available data. However, it is planned to treat this water as required (e.g., separation of any oils from tunnel sump water), and then temporarily store it in sedimentation basins near each shaft location. The water would evaporate or might be used for construction purposes such as dust control. Storage in either lined or unlined ponds should not measurably affect shallow groundwater quality since water quality in all hydrogeologic units down to tunnel depth is generally similar (Appendix 5, Table 5.6.2-6).



It is anticipated that approximately 3 million yd<sup>3</sup> of spoils would be generated from shafts and the tunnel at the Tennessee site. The material would mostly be carbonate rock with minor shale. Pyrite is common locally in most of the bedrock units and, thus, there is a potential for generation of a leachate containing iron and sulfur. However, when mixed with crushed limestone, which has a high capacity for retention of these substances, the spoils should not produce environmentally harmful leachates. Following temporary near-shaft stockpiling, three options for disposal or use are considered: 1) use for on-site construction aggregate and fill, 2) sell or provide to local aggregate or cement producers, and 3) dispose of in approximately 33 on-site piles with dikes and retention ponds. The first two options would result in a negligible impact to site groundwater quality. In both, the spoils material would be distributed to such an extent that any leachate generated would be of limited volume. The second option would result in the least impact to site groundwater quality. The third disposal option (diked piles) would have the potential for substantial leachate generation and a measurable impact to site groundwater quality, given the near-surface geologic conditions described previously. This impact could be mitigated by installing a low-permeability liner (e.g., clay) beneath the disposal piles. With some form of liners installed, the residual impact to groundwater quality would be negligible.

It is presently planned that all solid waste generated during construction and subsequent operations would be transported to an existing licensed landfill with available capacity (Rutherford County Landfill). Since disposal would be to an existing landfill, it is assumed that controls to protect local groundwater quality would be in place and that disposal of project waste would have little, if any, incremental effect on potential groundwater contamination from the landfill.

#### 5. Public Water Supply Systems

The estimated off-site rural and municipal water use associated with the project in Tennessee is summarized in Table 7-7. It was noted in discussion of water level/overdraft impacts that all except one major municipal supply system in the site vicinity uses surface water rather than groundwater. Consequently, during construction and operations there would be a negligible impact to all public water supply systems except for the College Grove Utility District.

College Grove is near the ring and would see some indirect project water use as well as being the designated supply source for service areas F7 and F8. As stated previously, the District is presently operating at about 50 percent of its capacity, with a daily use of about 75,000 gal. Total direct and indirect project demand on the system is not defined but might be on the order of 10,000 to 15,000 gal/d during construction and 140,000 to 160,000 gal/d during operations. Comparing this increase in use to system capacity, this suggests a negligible impact during

construction but a measurable impact during operations. There is no effective mitigation for the impact to the College Grove Utility District. However, the overall impact to public water supply systems is not considered significant since only one system would be measurably impacted.

## 6. Wells

The impact of administrative (land acquisition) or safety-related (nearness to tunnel - 150-ft radius) well closures would be measurable at the site level. Review of well records and reconnaissance surveys by the Tennessee Department of Health and Environment indicates that there are in excess of 500 domestic wells within 0.25 mi of the proposed tunnel alignment. Records indicate there are approximately 350 domestic wells within the SSC footprint. Only a small portion of these wells might be directly affected or require abandonment because of the project. The State estimates that less than 70 wells will be so impacted. This would still be a measurable impact on local water users and on local water use patterns. There would be a minor beneficial impact for the local groundwater system due to the well closures.

The impact to water users could be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better quality were provided. The State has indicated it will provide this mitigation. Even assuming this mitigation, there would still be a measurable, site level, and irreversible impact to local groundwater users. The impact is considered to be significant based on the number of wells and well owners that might be affected. It is noted that the significance and magnitude of this impact may change as well records and criteria for well closure are further defined.

## B. Operations

### 1. Water Levels/Overdraft

Groundwater from the College Grove Utility District is the proposed water supply source during operations for service areas F7 and F8. Even though projected operations use would be higher than during construction, only a negligible water level/overdraft impact is anticipated. As shown in Table 7-1, the annual total projected water use for each service area is about 80 acre-ft or 160 acre-ft for both F7 and F8. This amount of use is equal to an equivalent continuous pumping rate of about 100 gal/min at the College Grove Utility District source. Increased pumping of this amount should not result in measurable incremental water level declines more than a few hundred feet from the pumping well. This magnitude of withdrawal would not initiate local or regional overdraft.

There would be no water level/overdraft impacts related to groundwater inflow control for the tunnel during operations. Areas of significant groundwater inflow to the tunnel would be grouted or otherwise sealed during construction.

## 2. Water Quality

Groundwater quality impacts from all aspects of operations would be negligible. Minor and very localized effects on groundwater quality from surface sources are inevitable given the generally shallow water table, the existence of shallow dissolution or karst features in bedrock, and normal aspects of human use associated with the project. These negligible impacts would result from activities such as irrigation and fertilization of site landscaping, and vehicle use. Given the general quality of existing shallow groundwater (Appendix 5, Table 5.6.2-6), these types of sources should not measurably degrade existing conditions.

Impacts to groundwater quality from subsurface activities would also be negligible. There would be limited materials in the tunnel/shafts with a potential to contaminate groundwater, and strict control procedures would be in place for any materials present. The tunnel rock units have low hydraulic conductivity, except in dissolution zones where migration of any contaminants that might be introduced to groundwater is possible. However, it is likely that all dissolution zones would have been grouted or otherwise sealed to reduce groundwater inflow. This would limit the potential for contamination of groundwater within these more permeable zones.

Handling and disposal of sewage and cooling tower blowdown generated during operations are described in detail in Appendix 10. Planned options for disposal of both would have only a negligible impact on groundwater quality. Domestic sewage and cooling water blowdown from the campus area would be transported to the existing Murfreesboro wastewater treatment plant. Domestic sewage from the far cluster area would be treated by tertiary package treatment plants. Remote service area sewage would be treated by septic tanks and leach fields. Land disposal and septic tank systems would potentially introduce some level of constituents typical of domestic sewage, such as nitrates, to site groundwaters on a very localized scale. All on-site facilities would be permitted by the county and/or state and overall a negligible impact to site groundwater quality would result.

No specific plans for treatment/disposal of cooling tower blowdown were presented by the State. It is assumed that cooling tower blowdown will be disposed of by using brine concentrating units or side stream softening.

Groundwater quality impacts from direct and indirect groundwater use and solid waste disposal during operations were previously assessed as negligible (see Section 7.2.3.6.A.4, Construction - Water Quality).

### 7.2.3.7 Texas

#### A. Construction

##### 1. Water Levels/Overdraft

Use of both surface water and groundwater is proposed to meet direct SSC water requirements in Texas. Surface water is proposed to supply the campus and near cluster areas. Groundwater from the Ennis municipal supply system will supply the far cluster. Groundwater from new wells in the Woodbine and Twin Mountains aquifers is proposed to supply the eight remote service areas (F1 through F4; F6 through F9) around the ring. General locations where groundwater might be developed are identified on Figure 7-11.

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of in-migration of construction and operations workers and their dependents. This estimated water use is shown in Table 7-8. It varies from 255 acre-ft in 1989 to almost 1,800 acre-ft in 1992 and totals over 9,200 acre-ft for the planned 7-yr construction period. Operations indirect water use is anticipated to range from 1,090 to 1,425 acre-ft/yr. Most of the increased water use would occur in communities and rural areas in Dallas, Tarrant, and Ellis counties; minor increases are projected in five other surrounding counties (Figure 7-11).

Of the total on-site and off-site project water needs of about 3,265 to 3,600 acre-feet per year during SSC operations, about 73 percent (2,350 to 2,646 acre-feet/year) are projected to come from surface water sources and about 27 percent (915 to 954 acre-feet per year) from groundwater. The operational water needs of the project to be supplied from groundwater represent only slightly more than one percent of the total 1985 groundwater use of about 46,800 acre-feet in Dallas, Ellis, and Tarrant counties. In 1985, only about 6 percent of municipal supplies was obtained from groundwater. Due to the planned increased reliance by community water systems on surface water sources, the SSC project's dependence on groundwater is expected to become even less than projected above.

Water level/overdraft impacts from direct construction and operations water withdrawals would be measurable at the regional level and long-term. The Woodbine and Twin Mountains aquifers are confined aquifers with relatively low transmissivities. The Woodbine and Twin Mountains aquifers are also presently overdrafted regionally as evidenced by declining water levels. During 1985, the Woodbine and Twin Mountain aquifers were the primary sources of groundwater in Ellis County and provided 2,836 acre-ft and 5,774 acre-ft of groundwater respectively (Arnold 1988). Because the present overdrafting would be increased by construction water withdrawals and because the aquifers are the major supply aquifers in the area, the impact is considered to be measurable. There is no effective mitigation for the water level/overdraft impact.

The impact is not viewed as significant since the regional overdraft condition exists and project water requirements would increase the apparent level of overdraft only slightly.

Water level/overdraft impacts from indirect project water use during construction and continuing through operations would also be measurable at the regional level and long-term for the same reasons as for direct use. The Woodbine and Twin Mountains aquifers are used regionally for municipal water supply, and a presently undefined portion of projected indirect water use would be derived from them. Again, there is no effective mitigation for the water level/overdraft impact. There is a trend for municipal water supply systems in the area to convert to surface water supply sources as they become available. This may decrease the impact over the duration of the project but cannot be assumed to be a mitigation. The impact is not considered significant for reasons stated previously.

Minimal groundwater control would be required for construction of building foundations and shafts at the Texas site. Thin and discontinuous channel alluvium deposits are the only water-bearing deposits that may require some level of groundwater inflow control. There would be negligible water level/overdraft impacts from this minimal activity even if dewatering were employed.

There would be no water level/overdraft impact associated with tunnel construction. Groundwater inflow is anticipated to be essentially zero except where the tunnel passes at shallow depth beneath streams. Minor inflows of a few to a few tens of gal/min might occur in isolated fractures in weathered zones in the Austin chalk. Inflow would not be of a magnitude to have any water level or overdraft impact to the local groundwater system.

## 2. Recharge

Impact to groundwater recharge would be negligible. Recharge to the deep aquifers (Woodbine and Twin Mountains) occurs in outcrop areas to the west of the site. No data were available to characterize the total or unit area amount of recharge to shallow alluvial aquifers. However, based on the description of project facilities and construction in Appendix 1, only about 2.5 mi<sup>2</sup> of land would be disturbed by construction and/or would have project facilities built on it that could impede recharge. Since it is unlikely that recharge would be totally eliminated in all areas of project construction or land disturbance, the actual reduction in site vicinity recharge would be small.

The impact to recharge would continue to be negligible through project operations as there would be minimal, if any, further land surface disturbance or construction of impervious surfaces. Landscaped portions of project facilities may allow recharge at approximately predisturbance or natural rates.

An estimate of recharge rate would be developed during site characterization so that an estimate of recharge reduction volume can be developed.

### 3. Subsidence

There would be no subsidence impacts caused by construction or continuing operations groundwater withdrawals. The subsurface stratigraphy, a thin veneer of alluvial materials overlying thick marl and indurated chalk deposits and sandstone aquifers at depth, is not prone to subsidence even if project-related groundwater use was extensive.

### 4. Water Quality

Groundwater quality impacts from surface and subsurface construction and groundwater use associated with construction would be negligible. This assessment is based on the fact that only standard construction material and practices would be employed and that shallow site groundwaters are already characterized by moderate to high levels of dissolved solutes (Appendix 5, Table 5.7.2-6) and, therefore, are not highly sensitive to minor changes in common dissolved constituents. Total dissolved solids, sulfate, and nitrate locally exceed federal drinking water standards.

Because of the generally shallow depth to water in the surficial alluvial aquifers, localized water quality effects from surface disturbance, equipment operation, and minor leaks and spills of construction materials are inevitable. These would be minimized by proper construction practices and procedures for spill and leak response and cleanup.

Subsurface construction (shafts and tunnel) would occur primarily within the Austin chalk. Since there is little, if any, active groundwater movement within this formation, there would be no impact to groundwater quality.

Handling and disposal of wastewater derived from dewatering or construction sump pumping from shaft and tunnel construction, spoils from shaft and tunnel excavation, and solid wastes from construction and operations are described in detail in Appendix 10. These materials and activities would have negligible impact on groundwater quality.

Dewatering is not expected to be necessary at the Texas site (Volume IV, Appendix 10, Section 10.2.3.7). Therefore, there will be no impacts to groundwater quality from dewatering activities.

It is anticipated that approximately 2.6 million yd<sup>3</sup> of spoils would be produced from shafts and tunnels at the Texas site. The material would be approximately 70 percent chalk and 30 percent marl, both of which have a limited potential for leachate generation. Following temporary near-shaft stockpiling, four options for disposal are considered. These are: 1) sell or provide chalk to local cement plants, 2) use chalk for

construction material, 3) dispose of marl as fill in existing quarries, and 4) dispose of marl at existing landfills. Given the nature of the material, none of the disposal options would have more than a negligible impact on groundwater quality.

It is presently planned that solid waste generated during construction and operations would be transported to one or more of three existing landfills near the site. Since disposal would be to existing permitted landfills, it is assumed that controls to protect local groundwater quality would be in place and that disposal of project waste would have little, if any, incremental effect on potential groundwater contamination from the landfills.

## 5. Public Water Supply Systems

The estimated off-site rural and municipal water use associated with the project in Texas is summarized in Table 7-8. The impact to groundwater-based public water supply systems from indirect project water use during construction and operations would be negligible. As shown on Table 7-8, the majority of increased off-site water use is expected to occur in the Dallas-Fort Worth area, which is supplied by surface water. During construction and operations, less than 25 percent of the in-migration is expected to occur in Ellis County. The major portion of in-migration into Ellis County is expected to occur in Waxahachie, which has recently converted from a groundwater supply source to surface water from Lake Waxahachie and Lake Bardwell.

## 6. Wells

The impact of administrative (land acquisition) or safety-related (nearness to tunnel - within 150 ft radius) well closures would be negligible. It is estimated that less than 10 water wells occur in the SSC footprint. State records document two domestic wells. It is possible that none or a very limited number of wells would be directly affected or required to be abandoned by the project.

If wells are affected, the impact to water users could be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better quality are provided. The State has indicated it will provide this mitigation. It is noted that the magnitude of this impact may change as well location data and criteria for well closure are further developed.

## B. Operations

### 1. Water Level Declines

Water level/overdraft impacts during operations are as described in Section 7.2.3.7.A, Construction.

## 2. Water Quality

Groundwater quality impacts from operations would be negligible. Minor and very localized effects on groundwater quality from surface sources are inevitable given the generally shallow water table in the alluvial aquifer and normal aspects of human use associated with the project. These negligible impacts would result from such activities as irrigation and fertilization of the landscaping, and vehicle use and maintenance. Given that existing shallow groundwater has relatively high levels of dissolved solutes (Appendix 5, Table 5.7.2-6), these types of sources should not measurably degrade existing conditions.

Impacts to groundwater quality from subsurface sources would also be negligible. As discussed under Construction Impacts, the tunnel is completed primarily within the Austin chalk, which has very low hydraulic conductivity. There would be minimal if any groundwater movement at tunnel depth. Tunnel level within the Austin chalk is also above the regional groundwater level (hydraulic head) of the Twin Mountains/Woodbine aquifer.

Handling and disposal of sewage and cooling tower blowdown generated during operations are described in detail in Appendix 10. Planned treatment and disposal of both would have a negligible impact on groundwater quality. Domestic sewage from the campus area would be treated at a package tertiary wastewater treatment plant to be constructed on site. Domestic sewage from the far cluster area will also be treated by a package tertiary treatment plant. Remote service areas will have septic tanks and leach fields to treat domestic sewage. Septic tanks and leach fields would likely introduce some level of constituents typical of domestic sewage effluents, such as nitrate, at a very localized scale to site groundwater. The shallow alluvial aquifer at the Texas site presently shows a wide range in nitrate levels. All treatment/disposal facilities would need to be permitted by the County and/or State and an overall negligible impact to site groundwater quality would result.

Cooling tower blowdown generated at the campus area would be treated at the package plant to be built near the campus. Cooling tower blowdown from the far cluster and service areas (except for F3) would be discharged to evaporation ponds. Each pond would be approximately 19 acres in size. Residual salts would be disposed of at existing landfills. Cooling tower blowdown from service area F3 would be piped to a nearby operating wastewater treatment plant. Assuming that evaporation ponds would be lined, disposal of cooling tower blowdown would have no or negligible impact on groundwater quality.

Groundwater quality impacts from direct and indirect groundwater use and solid waste disposal during operations were previously assessed as negligible.



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