CHAPTER 4.0
ENVIRONMENTAL CONSEQUENCES

CHAPTER 4 - ENVIRONMENTAL CONSEQUENCES

4.1 Effects of Proposed Actions

This chapter presents a discussion of the effects of the proposed alternatives being studied under the flood damage reduction and ecosystem restoration program in the lower Colorado River basin that could result in subsequent recommendations for Congressional Authorization for construction. Impacts of these alternatives are disclosed. A comparison of the direct and indirect impacts for each alternative is presented. Direct impacts are those effects that are caused by the action and occur at the same time and place (section 1508.8(a) of 40 CFR Parts 1500-1508). Indirect impacts are those effects that are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable (section 1508(b) of 40 CFR Parts 1500-1508).

It has been determined during this review process that there would be no significant effects to climatology, geology, or physiography resulting from any of the proposed flood damage reduction or ecosystem restoration alternatives. Consequently, there will be no further discussion of these resources.

It should be noted that the specific impacts associated with any given project would be addressed in a separate, project-specific NEPA document.

For purposes of this evaluation, significance thresholds have been established for each of the resource categories. The significance categories are as follows:

Land Use

- The action is inconsistent with adopted land use plans.

Socioeconomics

- The action substantially alters distribution or location of the Regions of Influence (ROI) population.
- The action decreases jobs to a level that substantially raises the ROI unemployment rates, reduces income generation or affects the local housing market and vacancy rates.

Hydraulics and Hydrology

- The action exposes people to reasonably foreseeable hydrologic hazards such as flooding.
- The action adversely alters the duration and timing of stream flows.

Floodplains

- The action increases water surface elevations and results in a substantial increase in flooding or erosion.

Biological Resources (Vegetation, Wildlife, Freshwater Resources)

- The action causes the loss of a substantial number of individuals of any native plant or animal species that could affect abundance or diversity of that species beyond normal variability.
- The action results in the permanent loss or degradation of sensitive or rare habitats.

Soils

- The action causes severe erosion or sedimentation.
- The action results in the loss or degradation of prime or unique farmlands.

Wetlands

- The action results in a permanent loss of a wetland or wetland function.

Marine Resources and EFH

- The action causes the degradation or loss of EFH.
- The action results in the loss of public access to coastal and marine resources.
- The action causes substantial losses of fishery resources.

Water and Sediment Quality

- The action results in adverse affects to surface or ground water quality or quantity that results in a stream segment not meeting state water quality standards.

Threatened and Endangered Species

- The action results in the harm, harassment, or destruction of any endangered, threatened or rare species (including candidate species), its habitat, migration corridors or breeding areas.

Air Quality

- The action causes or contributes to a violation of state or federal ambient air quality standards.

Cultural Resources

- The action causes the disturbance or destruction of archeological or historical resources that are potentially eligible for, or are listed on the NRHP.
- The action results in the desecration or destruction to Native American resources.
- The action affects access to Native American traditional areas.

Recreation and Open Space

- The action results in the reduction or loss of existing recreation space.

HTRW

- The action increases exposure to hazardous, toxic or radioactive waste.
- The action increases the likelihood for a hazardous materials release to the environment.

Environmental Justice

- The action has disproportionately high cultural, ecological, economic, social or human health effects to minority and/or low-income populations;
- The action has disproportionately high cultural, ecological, economic, social or human health effects to children;
- The action has health effects that are above generally accepted norms and/or may include bodily impairment, illness or death.

4.1.1 Land Use

No Action

Land use would continue to change from the current land uses to mining, agricultural, and residential, commercial and industrial uses, especially within the Austin metropolitan area. Impacts to land use would continue to occur as urban and agricultural lands within the lower Colorado River basin would be subject to extreme flood events. Flood damages would likely cause the abandonment of some residential, commercial, industrial and agricultural areas within the basin.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Levees and floodwalls would alter land use within the footprint of those structures. Levees and floodwalls would also alter the land use within the footprint of the sump areas for interior drainage. Through reduction of the 100-year floodplain a levee or floodwall could increase the amount of land available for development within the study area. These structural measures would also increase floodplains immediately upstream and downstream of the project area altering their current land use. Floodwalls generally have smaller onsite impacts to land use than levees.

In most cases relief channels would not alter land use unless there is an existing residential or commercial development within the footprint of the structure since relief channels are generally located within the floodplain. Relief channels would cause a reduction in the 100-year floodplain that could increase the amount of land available for development within the study area. However, relief channels could also increase floodplains in downstream areas.

Diversion channels would alter land use within the footprint of the structures. Diversion channels would cause a reduction in the 100-year floodplain downstream on the creek or river of the project that could change the land use from additional development within the study area. However, diversion channels could also increase floodplains in downstream areas on the river or creek that is receiving the additional water from the diversion leading to a reduction in developable land area.

In most cases channel improvements would not alter land use since channel improvements are generally located within or directly adjacent to the creek. Channel improvements would cause a reduction in the 100-year floodplain that could increase the amount of land available for development within the study area.

Tunnels would alter land use within the footprint of the structures unless it is bored underground without ground-level disturbance. Tunnels would cause a reduction in the 100-year floodplain downstream on the creek or river of the project that could increase the amount of land available for development within the study area. However, tunnels could also increase floodplains in downstream areas on the river or creek that is receiving the additional water from the diversion.

Dry detention and detention basins would alter land use within the footprint of the basin. They would convert any uplands within the basin to floodplains and residential and commercial structures would have to be removed. In addition, land use would be altered in any areas used for obtaining fill for construction of the dam or excavated to create the basin. Some existing land uses would be able to remain; for instance, agricultural crop production and grazing could be allowed if only flood easement rights were purchased. If the basin was purchased with fee simple rights, then all existing land use would more than likely be converted to open space or recreation lands. Reduction of the 100-year floodplain from these structural alternatives could increase the amount of land available for development downstream of the basin. Detention basins are generally smaller scale than dry detention basins and would have fewer impacts on land use.

Multipurpose reservoirs would have the same impacts on land use as dry detention basins, however, the land use would be converted to water flowage easement. However, if the entire flood

pool was not purchased in fee, there would be flood easements that would fall under the same category as dry detention basins. In addition, land that is not within the floodplain would more than likely be purchased and converted to dam operations and maintenance lands and park and recreation lands.

Non-Structural Measures:

Buyouts generally convert residential or commercial landuse to recreation or open space. Floodproofing would not alter land use. Flood warning systems would not alter land use except for in the direct footprint of the sirens. Zoning would designate existing land use into land uses compatible with flooding. Existing facilities are generally not removed, but future development is curtailed. Land uses that are generally compatible with flooding include recreation and open space, agricultural production, etc. A change in gate operation in existing reservoirs by changing timing, duration, and quantity to lower floodplains within the basin of the reservoir (e.g. Highland Lakes Interim Feasibility Study for Lake Travis) would allow for increased residential and commercial development or urban development. However, the resulting increase in water surface elevations and floodplains downstream would affect landuse downstream by adding additional land to the floodplain. This could restrict residential development. Conversely, changing the gate operation in existing reservoirs to protect downstream users would increase floodplains within the basin and upstream of the reservoirs. This would alter landuse by adding additional lands to the floodplains and could restrict development.

General Ecosystem Restoration Alternatives:

Preservation would not affect land use as the current land use is generally what would be protected. Invasive species management and native species restoration would not affect land use since it would continue to be managed as vegetated open space.

Removal of existing levees, reconnecting abandoned oxbows, restoring abandoned gravel mines, reestablishment of riffle/pool sequences, and generally using earth moving equipment would alter current land use if the current land use was not designated as open space or water. Most of the restoration alternatives would establish additional vegetation, open space, or water.

4.1.2 Socioeconomics

No Action

A total of 12,400 structures with an estimated value of $845 million (in 2002) are located within the 100-year floodplain of the lower Colorado River. Annual flood damages within the

lower Colorado River basin are estimated to exceed $25 million. Large flood events, which will continue to occur under the No Action Alternative, will impact the socioeconomics of the region by damaging structures and their contents, and inundating cropland, causing losses in agricultural production. Future development within the Austin metropolitan area will create additional jobs and population growth providing a socioeconomic benefit regionally. However, impacts to housing and traffic in the region are also anticipated as the demand for additional, affordable housing increases and population growth increases traffic regionally.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Impacts to socioeconomics from the implementation of levees, floodwalls, relief channels, diversion channels, channel improvements and tunnels would be similar. With the implementation of any of these structural measures, the socioeconomics within the basin would be improved through reductions in losses associated with flood events and decreased flood insurance rates. For example, the socioeconomics of Wharton County would be directly improved by the measures proposed under the Wharton Interim Feasibility Study through reductions in losses associated with flood events (currently estimated to be nearly $4 million annually) and decreased flood insurance rates. Short-term benefits to the local service economy would be realized during the construction period. Short-term impacts would include increased traffic and noise associated with construction, structure removal and ecosystem restoration activities. These impacts would occur during normal business hours minimizing their effect.

The construction of dry detention basins, detention basins and multipurpose reservoirs would have impacts to socioeconomics similar to those described above, but could also reduce the local tax base if the land for the basins and reservoirs was purchased by the government. However, basins and reservoirs would provide some new recreational opportunities, such as boating and fishing in multipurpose reservoirs, and hiking, biking and hunting in basins, providing a minor economic benefit locally. Furthermore, socioeconomic benefits could be realized regionally from multipurpose reservoirs through hydropower generation. Alternatively, basins could be created by purchasing flowage easements, which would have smaller impacts on the local tax base and would provide no new recreational opportunities.

Non-Structural Measures:

Buyouts, flood proofing, flood warning systems and zoning would improve the socioeconomics in the basin through reductions in losses associated with flood events and decreased flood insurance rates. Buyouts and changes in zoning, depending on land-use, could result in adverse impacts to the housing sector of the economy and reductions to the local tax base. For example, evacuation of the 25-year floodplain in portions of Shoal Creek, Walnut Creek, Middle Williamson Creek, Onion Creek and Timber Creek could reduce the tax base in these affected areas, but in turn also reduce annual flood damages. Short-term benefits to the local service economy would occur during the implementation of flood proofing and flood warning systems.

Changes in gate operations at dams associated with multipurpose reservoirs could have beneficial or adverse impacts to socioeconomics of the area immediately surrounding the reservoir, based upon the proposed changes. For example, a change in gate operations that would result in reduced flood events would have a beneficial impact on socioeconomics in the Lake Travis area. However, increased flooding downstream of Lake Travis through Bastrop County from a change in gate operations would decrease available land for development and cause localized increases in flood damages.

General Ecosystem Restoration Alternatives:

Preservation, invasive species management, native species restoration, and the removal and construction of structures would provide short-term benefits to the local service economy during the construction phase of the projects and long-term localized economic benefits from recreational use of the restored areas. A reduction in the local tax base would occur if project lands were removed from private ownership.

4.1.3 Hydraulics and Hydrology

No Action

Future growth and land development (e.g. highways and roadways, housing developments, parking lots) within the basin, especially in the Austin metropolitan area, will increase the impermeable surface area, potentially impacting the hydraulics and hydrology of the lower Colorado River through increased surface runoff, and timing, duration and velocity of flood events. However, due to local flood control measures implemented by others, peak flows would remain relatively stable on tributaries, primarily in the COA. Further, it would not have a substantial effect to the hydraulics and hydrology of the lower Colorado River. Major flood events would not be controlled in most of the

basin, causing continued flood damage. Building water supply reservoirs as proposed in the state water plan and the LCRA SAWS project would alter the hydraulics and hydrology of the basin by altering the timing, duration, and quantity of peak flows in the basin and Matagorda Bay.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Construction of levees and floodwalls would confine flood flows and increase water velocities downstream of the project area. Where channel reaches would be protected by levees and floodwalls (e.g. Colorado River in Wharton County, and Onion Creek, Walnut Creek, Peach Creek, Boughman Slough and Caney Creek), peak water surface elevation would increase immediately upstream and downstream of the levees and floodwalls in response to channel confinement. Where levees and floodwalls are constructed, there would be a reduction in the number and frequency of events during which flows of the lower Colorado River and tributaries cause significant structural damage. Confinement of the lower Colorado River in Wharton County would result in a decrease of flows in Peach Creek and Boughman Slough within Wharton County, especially during flood events and periods of high rainfall.

Construction of relief channels (e.g. Onion Creek) would improve local floodwater storage and conveyance and reduce water surface elevations in the stretch of the stream channel that is cutoff by the relief channel and upstream of the relief channel.

Diversion channels (e.g. Shoal Creek) also improve local floodwater storage and conveyance and reduce water surface elevations upstream and downstream on the creek where the diversion is located. However, diversion channels can increase stream velocities and raise water surface elevations in the stream channel that receives the diverted water.

Channel improvements (e.g. Shoal, Onion and Walnut Creeks and the Colorado River in Wharton County) would reduce water surface elevations at the location of the improvement and immediately upstream, but would slightly raise water surface elevations downstream of the improvements.

Construction of tunnels (e.g. Shoal Creek) would reduce flood flows and flow velocities through the project area. Additionally, water surface elevations would increase immediately downstream of tunnels.

The construction of dry detention basins (e.g. upstream of Lake Buchanan on the mainstem of the Colorado River or on the Llano River), detention basins (e.g. Walnut Creek) and multipurpose reservoirs would increase upstream storage and reduce downstream flow velocities and peak flows. The timing and duration of freshwater flows into Matagorda Bay would be altered with dry detention basins, detention basins and multipurpose reservoirs. Furthermore, there would be a net reduction in the amount of freshwater flows into Matagorda Bay with the construction, filling and operations of multipurpose reservoirs.

Non-Structural Measures:

Buyouts would decrease the amount of impervious cover in the floodplain, which would allow more infiltration and reduce peak flow, although these effects would be localized. Flood proofing, flood warning systems and zoning would have no impacts to the hydraulics and hydrology in the lower Colorado River basin. Changes in gate operations at any existing reservoir would alter the overall hydrology of the lower Colorado River through the Highland Lakes system by decreasing the 100-year water surface elevation in the reservoir where gate operations change and potentially increasing stream velocities and flows below the dam for selected recurrance intervals. For example changes in gate operations at Lake Travis would lower the 100-year water surface elevation in Lake Travis but would cause increases in peak flows in Austin and Bastrop County. However, no substantial changes in peak flows would occur downstream of Bastrop County from changes in gate operations at Lake Travis. Changes in gate operations would alter the timing and duration of flood events within the flood pool as well as downstream of the dam.

General Ecosystem Restoration Alternatives:

Preservation of habitats within the lower Colorado River basin would have no impacts to hydraulics and hydrology. Native species restoration would decrease the amount of impervious cover in the restoration areas, allowing more infiltration and a reduction in peak flows locally. The removal of structures would decrease roughness and increase flow velocities and reduce water surface elevations. Restoring plants in areas that are currently denuded of vegetation would increase roughness in the channel and would raise water surface elevations for a given discharge. However, these changes in hydraulics and hydrology would be minor and very localized.

4.1.4 Floodplains

No Action

Based on the computed flood elevations, 449 square miles of the lower Colorado River basin would continue to be susceptible to 100-year flood events under the No Action Alternative. Some of the local flood control projects proposed by others, such as the COA, would reduce the size of floodplains in localized areas along tributaries of the Colorado River. Navigation and restoration projects that would occur within the study area in the future could alter the boundaries of the 100-year floodplain and would likely result in a localized increase in floodplain area. Additionally, private development within the Austin metropolitan area could reduce flood storage and floodplains by the placement of fill within the floodplain. The No Action Alternative would result in continued or increased flooding of existing structures and property within the floodplain and additional flooding of new development constructed without adequate flood protection measures. Increased development within the floodplain would adversely affect the floodplain along localized tributary reaches, but would not result in regional impacts to the 100-year floodplain along the mainstem. Construction of water supply reservoirs under the state water management plan and the LCRA/SAWS project would reduce floodplains downstream of the dam or diversion point and likewise would raise floodplains upstream of the dam.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

In areas adjacent to levees and floodwalls, the 100-year flood elevation would be reduced. However, slight increases in the 100-year floodplain immediately upstream and downstream of levees and floodwalls would occur. For example, the construction of levees along portions of the lower Colorado River in Wharton County and along Boughman Slough would reduce the 100-year floodplain in most of the developed portions of the City of Wharton but would cause a slight increase in water surface elevations of the Colorado River below Wharton in Matagorda County.

Construction of relief channels, channel improvements, and tunnels would reduce floodplains upstream and in the immediate area of the structural measure, while diversion channels reduce floodplains upstream and downstream of the diversion inlet. However, diversion channels can cause an increase in the floodplain area in the creek where the water is diverted and likewise the other measures can cause downstream increases in floodplain area.

Construction of dry detention basins upstream of the Highland Lakes would lower the 100-year flood elevation from the dam to Lake Travis but would have small effects on the floodplains downstream of Lake Travis. In similar fashions, the construction of multipurpose reservoirs, would reduce the magnitude and frequency of flooding downstream and would reduce downstream floodplain elevations.

The construction of detention basins on tributaries (e.g. Walnut Creek) would increase upstream storage and reduce 100-year flood elevation downstream of the basin.

Non-Structural Measures:

Buyouts and flood proofing would cause minor localized decreases in the 100-year floodplain through a reduction of impervious surfaces and structures in the floodplain. Flood warning systems and zoning would have no impact to floodplains in the basin. Changes in gate operations at any existing reservoir would affect the 100-year flood pool of the reservoir and the 100-year floodplain downstream of the dam. These changes in the 100-year flood elevation would be related to the type of gate operation changes that are implemented. For example, changes in gate operations at Lake Travis would likely lower the 100-year flood pool in Lake Travis but increase the 100-year flood elevation downstream of Lake Travis through Travis and Bastrop counties.

General Ecosystem Restoration Alternatives:

Preservation of habitat, invasive species management, and native species restoration would have no impact to floodplains. Removal and construction of structures for ecosystem restoration would cause localized changes in the 100-year floodplain based on the type of structural alteration that occurs within the floodplain.

4.1.5 Vegetational Areas and Soils

No Action

Vegetation would continue to be lost from construction and development of projects proposed by others under the No Action Alternative along with the general trend of increasing development within the basin. Furthermore, gravel mining activities, agricultural practices, and water supply reservoirs could cause the loss of riparian habitats within the basin.

Most of the future land development and the associated loss of soils would occur in the Austin metropolitan area. Sand and gravel mining within the basin would also continue to cause a loss of biologically productive soils within the Colorado River floodplain. Additional flood events

within the basin would lead to increased soil erosion and loss of topsoil from agricultural areas. Construction of water supply projects would result in a loss of vegetation within the footprint of the reservoir and would result in altered vegetation downstream of the dam due to reduced overbank flooding.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Levees and floodwalls would result in a loss of vegetation during construction. Levees generally have larger footprints which cause more impacts. Vegetation impacted by levees and floodwalls would be associated with floodplains and riparian ecosystems. This would include bottomland hardwood and wetland habitats if they are present. Vegetation would also be lost when constructing temporary construction easements, access, equipment storage areas, sump areas and borrow pits. As a result of the levee or floodwall, changes to vegetation composition and structure in the vegetation communities on the outside of the feature would likely become dominated by drier, upland species. Vegetation communities downstream and upstream of the features that were not susceptible to historic flooding could become dominated by vegetation that could sustain periodic flooding. Soil disturbance and increased propagule load introduced through floodwaters could result in the colonization of previously absent plant species, including invasive and exotic species. Finally, the areas remaining as borrow pits or low lying areas that serve as interior drainage would more than likely transition to wetland vegetation.

As with levees and floodwalls, relief channels, diversion channels, and channel improvements would result in a loss of vegetation during construction. Generally the vegetation would be associated with floodplains and riparian ecosystems. This would include bottomland hardwood and wetland habitats if they are present. Vegetation would also be lost when constructing temporary construction easements, access, and equipment storage areas and at disposal sites. As a result of the features, changes to vegetation composition and structure in the vegetation communities outside of the feature would likely become dominated by drier, upland species. Vegetation communities downstream of the features that were not susceptible to historic flooding would become dominated by vegetation that could sustain periodic flooding. Soil disturbance and increased propagule load introduced through floodwaters could result in the colonization of previously absent plant species, including invasive and exotic species. As with any disturbed soils, there would be increased opportunities

for invasive species to proliferate. Over time, the relief channels or diversion channels would more then likely have parts of the channels that have facultative vegetation and function somewhat as a wetland depending on what increment of flow (i.e. the 10-year, 25-year, etc.) the channel would pass and what materials it is constructed with. Depending on what stabilization measures are implemented in connection with the channel improvements there would be the potential for vegetative stabilization features that would incorporate riparian or wetland vegetation. On the other hand, if armoring with impervious cover is utilized for stabilization, then there would be little chance for establishment of vegetation.

A loss of vegetation would result during the construction of tunnels. Generally the vegetation would be associated with floodplains, riparian ecosystems, and aquatic vegetation. This would include bottomland hardwood and wetland habitats if they are present. Vegetation would also be lost when constructing temporary construction easements, access roads, and equipment storage areas and at disposal sites for excess soils. As a result of the tunnel, changes to vegetation composition and structure in the vegetation communities between the tunnel intake and outlet would become dominated by drier, upland species. Vegetation communities downstream of the tunnel outlet that were not susceptible to historic flooding would become dominated by vegetation that could sustain periodic flooding. Soil disturbance and increased propagule load introduced through floodwaters could result in the colonization of previously absent plant species, including invasive and exotic species.

Construction of dry detention basins and detention basins would result in changes to vegetation composition and structure and potential loss or conversion of vegetated areas in the footprint of the reservoir and borrow pits. Impacts to upland vegetation would be minimal due to the fact that water would recede relatively quickly in most cases. Vegetation in the 25-year, 10-year, and 2 to 5-year flood foot print of the basin would be most affected as they would be inundated much more frequently. Vegetation in the 2 to 5-year floodplain would migrate to species that would tolerate frequent flooding. Soil disturbances and increased propagule load introduced through floodwaters could result in the colonization of previously absent plant species, including invasive species. The composition and structure of the vegetation community in the floodplain downstream from the dam would change due to a decrease in overbank flooding. The vegetation communities in the downstream reaches would likely become dominated by drier, upland species.

Multipurpose reservoirs would replace existing vegetation within the conservation pool with aquatic habitat. This could result in a total loss of riparian habitat along the inundated creek or river.

Existing vegetation communities around what would become the perimeter of the reservoir would be replaced with more water-dependent species over time. Wetlands and vegetation communities typical of floodplains would emerge along the backwater portions of the reservoir. Downstream from the reservoir, the composition and structure of the vegetation composition in the floodplain would change due to a decrease in overbank flooding. The vegetation communities in the downstream reaches would likely become dominated by drier, upland species.

The construction of levees and floodwalls would result in the loss of soils within the footprint of the construction area, borrow pits and sump areas. Those areas on the outside of the features would no longer receive alluvial deposits. In addition, there would be increased scour and erosion downstream of the levee or floodwall.

The construction of relief and diversion channels would result in the removal of soils within the footprint of the construction area. The soils removed during construction would have to be disposed of, which would alter soils at the disposal site. If the soils were conducive for use, then the soils would more than likely be utilized for levee construction to minimize overall soils impacts and disposal costs. For example, there would be loss of soils if relief channels or diversion channels were constructed on Onion Creek and in Wharton. If the excavated soils meet engineering standards, they would be utilized during construction of levees at these sites.

Dry detention basins, detention basins, and multipurpose reservoirs would result in the loss of soils within the footprint of the construction area including borrow pits. The construction of dry detention and detention basins and multipurpose reservoirs could also result in the loss of prime farmland depending on the location. Significant amounts of sediment carried by the project waterway would be captured within the reservoir or basin reducing the deposition of sediments in the downstream reaches. There would be increased scour and erosion downstream of the dam.

Non-Structural Measures

Buyouts, floodproofing, and flood warning systems would result in temporary vegetation removal in the vicinity of the structures, along access routes and in areas of equipment storage.

Zoning would likely protect existing vegetation from being impacted by future development. Some local and county governments could implement ordinances to ensure that riparian vegetation is not altered. Gate change operations at existing reservoirs would have very high impact to vegetation or soils.

General Ecosystem Restoration Alternatives:

Preservation would protect vegetation from being negatively affected. Generally with preservation, vegetation would mature to a more climax condition.

Invasive species management would result in an elimination of invasive or exotic vegetation. There would be a gain of native vegetation that was historically present in the area before invasive vegetation developed.

The construction or removal of structures would result in a direct loss of vegetation in the footprint of the project; however, there would be a gain of historic vegetation communities for the entire project area.

All ecosystem restoration measures would result in an impact or disturbance to soils as a result of construction or planting of native vegetation.

4.1.6 Wildlife Resources

No Action

Fragmentation and loss of habitat would continue to impact wildlife under the No Action Alternative since numerous projects proposed by others within the basin would still be implemented. However, many of the proposed future projects would occur in already developed or disturbed areas. Sedentary or locally mobile wildlife species would be impacted from continued flood events under the No Action Alternative. Additionally, some wildlife habitat would be altered or lost from scour and erosion due to extreme flood events. Ecosystem restoration projects proposed at Town Lake, Lake Austin and in Matagorda County adjacent to the GIWW will protect and restore habitat for wildlife within the basin. Water supply reservoirs proposed by others would result in a loss of terrestrial wildlife habitat, but would result in a gain of aquatic resources that wildlife would utilize.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Levees would have an impact to wildlife through the loss of sedentary and slow moving species during construction. However most of these species would be common locally and regionally. During construction, noises may have temporary affects on wildlife causing them to avoid the areas. The associated loss of riparian habitat from direct impacts and reduction of the floodplain would also have an impact on wildlife utilizing those areas, but affects are mostly localized. The

impact would be primarily to smaller species such as amphibians and reptiles with narrow habitat requirements and riparian-dependent bird species. The presence of levees should not result in a fragmentation of habitat as larger wildlife species would cross over levees.

Floodwalls would have impacts to wildlife similar to those of levees; however, floodwalls could restrict some wildlife species from water sources and habitat depending on the height of the floodwall and the home range of the species.

Relief channels and diversion channels would have impacts to wildlife similar to those of levees. Habitat fragmentation could restrict wildlife species from utilizing both sides of any remaining riparian area, depending on the size of the channel. The impact would be primarily to smaller species with narrow habitat requirements and riparian-dependent bird species. Relief and diversion channels could also create wildlife habitat, including wetlands, if the channels are not lined with impervious cover or mowed.

Channel improvements would have impacts to wildlife similar to those of levees. Channel improvements would normally have a smaller direct affect on habitat than levees would. Aquatic habitat would generally be lost due to channel improvements. If impervious cover is used for stabilization, then aquatic habitat is lost completely. Conversely, if impervious cover is not utilized, then aquatic habitat would return over time, but probably not to the extent that it existed prior to construction.

Tunnels would result in a loss of riparian habitat through construction impacts and alteration of soil moisture content where riparian habitat exists between the inlet and outlet structure. Construction activities could result in the direct removal of exisiting riparian habitat. Opertion of tunnels would convert the project area to a drier, upland habitat benefiting species that prefer those habitats.

Dry detention and detention basins would result in habitat loss during construction of the dam and excavation of borrow pits. There would be temporary effects on wildlife during every rain event where water would be impounded. During large rainfall events there could be continued impacts to smaller species as the basin is flooded. The periodic flooding of the basin would alter the diversity of its wildlife and wildlife habitat. The riverine habitat would be altered due to increased amounts of aggradations from the dam. Riparian habitat downstream of the dam could be lost due to reductions in the floodplains, however, more riparian habitat would form within the basin behind the dam. Detention basins are generally smaller in scale and therefore affect fewer habitats. In addition, detention basins can benefit water quality, which benefits terrestrial and aquatic wildlife.

Multipurpose reservoirs have similar effects on wildlife as dry detention basins except the footprint of the multipurpose reservoir would be replaced with aquatic habitat. Riverine habitat would be lost, including many miles of bottomland hardwood habitat which is recognized as one of the most valuable wildlife habitats. Reduction of the floodplain and reduction of over bank flooding events in the downstream reach would alter the composition and diversity of wildlife species using the floodplain. However, the headwaters of reservoirs over time would form very valuable forested wetland and bottomland hardwood habitats because of siltation.

Non-Structural Measures:

Buyouts would have very minimal losses of wildlife habitat during the removal of structures, construction easements and access, and storage of vehicles. During construction, noise levels may cause wildlife to temporally avoid the areas. Buyout areas would be restored or turned into parklands or open space which would ultimately benefit wildlife species. Buyouts could open new migration corridors.

During construction of floodproofing and flood warning systems, noise levels may cause wildlife to avoid the areas. There would also be a minor loss of habitat from construction easements, access and equipment storage.

Zoning would likely benefit wildlife by protecting habitat within the floodplain. However, if no protection ordinances are established, there could be impacts to wildlife habitat from private property owners removing vegetation. Changes to gate operations at existing reservoirs could have short term effects to sedentary wildlife species within the reservoir and downstream during extreme flood events as water is differently impounded or released. These impacts would be minor since they would occur at 10-year storm events.

General Ecosystem Restoration Alternatives:

All restoration measures would result in an overall gain of wildlife habitat. The program alternatives would restore habitats associated with water resources. These include but are not limited to: riparian woodland including bottomland hardwoods, wetlands, aquatic riverine and lacustrine, scrublands, and grassland habitats within the floodplains. In some cases, work in the uplands would be carried out to restore flows to the creeks. This would include brush management on hydrophytic vegetation. During construction and restoration implementation, some wildlife habitat would be lost or converted; however, more beneficial habitat would be restored.

4.1.7 Freshwater Resources

No Action

Numerous reservoirs, both in-stream and off-channel, provide water supply, recreation, irrigation and hydropower in the lower Colorado River basin. Furthermore, the lower Colorado River and its tributaries are important aquatic resources. Future projects implemented to address unmet water needs in the basin could reduce the water levels and flows in tributaries and in the lower Colorado River. Continued uncontrolled flooding would potentially disrupt water supply, hydropower and recreation use, and damage irrigation infrastructure in the basin.

As additional mining and development projects are implemented in the basin, they are expected to change freshwater flow, as well as timing and duration of flood events impacting riverine, lacustrine and estuarine resources. Impacts from increased scour and downstream sedimentation could occur to all three of these aquatic habitats. However, uncontrolled flooding does not necessarily have detrimental effects to fish and wildlife species and the ecosystem as a whole. Historically, flooding has played an active role in the lower Colorado River ecosystem.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Levees and floodwalls reduce the available organic matter input into stream channels during flood events and reduce the floodplain area for aquatic and semi-aquatic species that rely on floodplain habitats for a portion of their life cycle.

Fish and invertebrate species could be introduced to new stream channels from the implementation of relief and diversion channels. Additionally, based upon the flood flows captured by relief and diversion channels (e.g. 25-year flows), fish and aquatic invertebrate species could become stranded in these channels.

Alteration of channel hydrology and structure associated with channel improvements would alter the composition of fish and invertebrate species. Changes in stream velocities as a result of channel improvements could cause increased sedimentation upstream of the improvements and increase sediment loads downstream of the improvements during peak flow events that could alter existing habitats.

Construction of tunnels and subsequent confinement of the stream channels would result in increased sediment loads downstream during peak flow events and increased sedimentation up-

stream of tunnels altering existing habitats. Tunnels constructed as bypass channels for high flow events could cause fish and aquatic invertebrate stranding and the introduction of species to different stream channels. In addition, water discharging from the outlet would be lower in dissolved oxygen than normal stream water, unless devices were utilized to replace lost oxygen, which would have affects to the downstream aquatic habitat.

Construction of dry detention basins, detention basins and multipurpose reservoirs would cause a portion of the lower Colorado River or its tributaries (e.g. detention basin on the Llano River) to no longer function as natural streams, immediately upstream of the dam. Flows would be decreased downstream of the basins and reservoirs, reducing the area of floodplain and causing the loss of secondary channels and riparian habitat.

Dry detention basins, detention basins, and multipurpose reservoirs would also alter the timing and duration of instream flows in the Colorado River. Seasonal, short-duration peak flows would be reduced and spread over a longer period. The altered flow characteristics would favor aquatic species downstream that prefer more constant and even flows. Aquatic species that prefer significant seasonal fluctuations in flow or require high flow events for channel scouring would be impacted. Aquatic resources immediately downstream of reservoirs would be affected from a reduction in the frequency of flushing events.

Multipurpose reservoirs would replace riverine and terrestrial habitat with lacustrine habitat significantly increasing the amount of aquatic habitat present. Fish and invertebrate species composition would change from riverine species to lacustrine species. Riverine habitats upstream and downstream from the reservoir would be altered by a reduction in flow rates. Downstream, overbank flooding and backwater flooding would be reduced.

Non-Structural Measures:

Non-structural measures such as buyouts, flood proofing, flood warning systems and zoning would have minimal effect on freshwater resources. Buyouts have the potential to improve water quality through a reduction in herbicide and pesticide use and the removal of structures within the floodplain. Changes in gate operations such as those proposed for Lake Travis would have little effect on the aquatic resources within the reservoir. Changes in gate operations would result in a change in the discharge from the dam, altering downstream flows. For example a change in gate operations at Lake Travis would increase flow in the Colorado River through Travis and Bastrop counties causing increased channel scour and erosion.

General Ecosystem Restoration Alternatives:

All ecosystem restoration measures would benefit freshwater resources within the lower Colorado River basin. Removal of structures and native species restoration would reduce the amount of impervious cover resulting in a long-term benefit by reducing pollution in runoff into the stream. Preservation of existing habitats would provide similar benefits. Invasive species management would greatly benefit native plants, fish, and aquatic invertebrates.

4.1.8 Wetlands

No Action

Projects proposed by others could result in the loss of wetlands from construction activities under the No Action Alternative. Additionally, several of the navigation projects proposed at the mouth of the Colorado River and in Matagorda Bay could cause wetland loss or a reduction in wetland functions from construction and operations. On the other hand, wetlands would be created or restored in many cases from dredging activities. Large uncontrolled flood events have the potential to impact wetland vegetation from scouring and erosion, as well as increased sedimentation, depending on where they are located within the floodplain relative to the flood event. The protection and restoration of wetlands from other proposed wetland and aquatic ecosystem restoration projects, such as the Mad Island Marsh Restoration project, will occur under the No Action Alternative.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Losses of wetlands would likely occur within the footprint of levees and floodwalls. Additionally, levees and floodwalls could hydrologically isolate wetlands located on the landward side of the structures. Borrow pits used during the construction of levees could be converted to aquatic and wetland habitat. Increased flow rates due to channel confinement could cause increased drainage rates, scour and erosion causing the loss of some wetland areas. Associated reductions in overbank flooding could also result in wetland loss.

The construction of relief and diversion channels could cause the loss of wetlands within the footprint of the construction areas. However, new floodplain wetlands could be created adjacent to and within new relief and diversion channels based upon the amount of flow captured by these

channels (i.e. 10-year flows, 25-year flows) and the materials used to line the channels. Increased flow rates as a result of relief channels could result in a decrease in wetland area along tributaries and backwaters due to increased drainage rates, scour and erosion. Associated reductions in overbank flooding could also result in wetland loss.

Construction of channel improvements and tunnels could cause the loss of wetlands within the footprint of the improvements. Increased flow rates as a result of channel improvements in the lower Colorado River, channelization of tributaries, and tunnels have the potential to result in a loss of wetlands due to increased scour and erosion as well as through a reduction in overbank flooding. Increased sedimentation rates in the Matagorda Bay estuary from the transport downstream of confined sediments, would likely cause the creation of additional wetlands in the Colorado River Delta.

Depending upon their design and operation, dry detention basins, detention basins and multipurpose reservoirs could cause the loss of wetlands through permanent or semi-permanent flooding. These structures could also cause an increase in wetland area due to periodic inundation of existing uplands. Some wetland area may be lost from the construction of dams and associated infrastructure. Wetland areas supported by stream flows downstream of basins and multipurpose reservoirs could be lost by a decrease in instream flows downstream of dams. Multipurpose reservoirs would result in a net loss of available freshwater downstream of the dam potentially causing a loss of wetlands that are hydrologically dependent on Colorado River flows.

Non-Structural Measures:

Non-structural measures such as buyouts, flood proofing, flood warning systems and zoning, would have no impact on wetlands with the basin. However, changes in gate operations at existing reservoirs, such as at Lake Travis, could potentially result in changes in wetland area, especially in backwater areas where the water surface elevation of the reservoir is reduced. A change in gate operations also has the potential to affect floodplain wetlands and other wetlands within the riparian zone downstream of the dam. For example, a change in gate operations at Lake Travis would increase floodplain elevations increasing the potential for an increase in wetlands downstream of Lake Travis through Bastrop County.

General Ecosystem Restoration Alternatives:

The preservation and restoration of wetlands would increase the wetland area within the basin and potentially improve the functions and values of existing wetland habitats. Furthermore,

the removal of invasive species and the restoration of native species would also increase wetland functions throughout the basin.

4.1.9 Marine Resources Including Essential Fish Habitat

No Action

Changes in estuarine dynamics and sedimentation patterns from navigation projects proposed in Matagorda Bay and at the mouth of the Colorado River could impact marine resources; changes in navigation patterns as a result of these projects could also impact fisheries and habitat susceptible to wave erosion and disturbance. Historically, flooding was beneficial to the ecosystem as a whole, including riparian and riverine resources and EFH. However, construction that has occurred in the floodplain has greatly altered the natural hydrology of the lower Colorado River impacting resources that rely on natural flood events. A reduction in freshwater inflows from increased water demands in the basin, including the construction of water supply reservoirs, could alter salinities in the estuary and affect the productivity of the estuary. Local flood control projects, such as those proposed by the COA, would not substantially affect freshwater flows to Matagorda Bay. However, water supply reservoirs would alter the timing, duration, and flow to the bay. As the human population in the basin increases, it is likely that there will be an increased demand on fishery resources and habitat. Development and growth in the watershed increases the impermeable surface area leading to an increase in the pollutant load transported to the estuarine and near-shore environment. Protection and restoration of wetlands from the Mad Island Marsh project will benefit marine resources through increased habitat and improvements in water quality.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Levees, floodwalls, relief channels, diversion channels, channel improvements, and tunnels constructed in all counties, except Matagorda County, would have no effect on marine resources, including essential fish habitat as they would not significantly affect stream flows in the coastal reach of the river. Levees, floodwalls, relief channels, diversion channels, channel improvements, and tunnels constructed in Matagorda County could alter the timing and duration of flood events and subsequent freshwater inflows on submerged aquatics and cause sediment to be transported further downstream and deposited in the estuarine areas of Matagorda Bay. This deposition could build

wetlands and mudflats but could also bury shell beds, reefs, and submerged aquatics. Without careful planning and analysis, the construction of levees, floodwalls, relief channels, diversion channels, channel improvement projects, and tunnels in Matagorda County could result in hydrological alterations to the downstream Matagorda Bay esturary and the dredging and filling of riverine and esturarine habitats, including tidally influenced wetlands and open water.

Dry detention basins and detention basins have the potential to reduce the quantity of freshwater flowing to Matagorda Bay estuarine and marine systems during periods of peak flows. Additionally, the timing of and duration of freshwater flows to the bay would be altered, which may affect EFH by altering seasonal salinity patterns. However, during the construction, flooding and operation of multipurpose reservoirs (including water use), there would be a substantial net decrease in the volume of freshwater that reaches Matagorda Bay. Some sediment currently deposited in Matagorda Bay during flood events and responsible for building wetlands and mudflats would likely be deposited in the detention basins and multipurpose reservoirs. If these facilities are constructed below the Highland Lakes, this would have a negative impact to fish and marine resources dependent on wetlands, submerged aquatic vegetation and mudflats.

USACE would consult with NMFS as required by the Magnuson-Stevens Act prior to any final federal action on proposed projects pursued under the LCRBS. All adverse impacts to EFH and associated living marine resources will be avoided and minimized to the greatest practicable extent. All unavoidable impacts would be mitigated in consultation with NMFS.

Non-Structural Measures:

Non-structural measures such as buyouts, flood proofing, flood warning systems and zoning would not impact marine resources or essential fish habitat. Furthermore, changes in gate operations at existing reservoirs would not cause changes in freshwater flows downstream of Bastrop County and, therefore would not impact marine resources.

General Ecosystem Restoration Alternatives:

Ecosystem restoration measures such as habitat preservation, invasive species management, native species restoration, and the removal and construction of structures implemented in the Highland Lakes and Central reaches of the Colorado River would have no substantial effect on marine resources, including essential fish habitat. Ecosystem restoration measures implemented in the Coastal Reach of the Colorado River could affect marine resources and EFH by increasing the

amount of coastal wetland and mudflat habitat area and providing improvements in estuarine water quality.

4.1.10 Water and Sediment Quality

No Action

Under the No Action Alternative, the impermeable surface area within the basin would increase as additional transportation, drainage, flood control, and residential and commercial development projects are constructed. Water and sediment quality would be impacted from increased runoff from future developed areas carrying pollutants from those impermeable areas into the lower Colorado River. Increased vehicle use and commercial and industrial discharges into the lower Colorado River and its tributaries will also increase the pollutant load in the river. Water quality measures implemented by COA and LCRA would reduce some of these impacts.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Construction of levees, floodwalls, relief channels, diversion channels, and channel improvements would result in a temporary increase in suspended sediment loads resulting in reduced water quality in the affected stream. Increased channel confinement from the implementation of these structural measures could increase the sediment load that is currently deposited in the project area floodplain and carry it further downstream.

Alternately, relief channels and diversion channels can capture sediments from the design flood flows and keep sediments from being discharged further downstream. However, diversion channels and tunnels can impact water quality by transferring water from a stream with poor water quality to one with high water quality. In addition, the water being transferred could be low in dissolved oxygen, which would negatively affect water quality.

Construction of dry detention basins, detention basins, and multipurpose reservoirs would cause soil disturbance leading to a temporary increase in suspended sediment loads reducing downstream water quality. However, once constructed, dry detention basins, detention basins and multipurpose reservoirs would capture sediments and pollutants, especially during peak flood events, removing them from the system and improving water quality downstream of the dam.

Non-Structural Measures:

Buyouts and flood proofing would have beneficial impacts to water quality during peak flow events by reducing the amount of contaminants and debris entering the system from flooded residential, industrial and commercial structures. Flood warning systems and zoning would have no substantial impact on sediment and water quality in the basin. Changes in gate operations would have little effect on water and sediment quality within the Highland Lakes system. However, if gate operations occurred at Lake Travis sediment loads downstream of Lake Travis would increase because of increased flows downstream of Lake Travis.

General Ecosystem Restoration Alternatives:

Any increases in wetland area or riparian vegetation resulting from native species restoration, habitat preservation or the removal and construction of structures would have beneficial long-term impacts to water and sediment quality as these areas function as filters by removing pollutants and capturing sediments.

4.1.11 Threatened and Endangered Species

A total of 25 Federally listed or candidate species have the potential to occur in counties that border the Colorado River study area. Another 15 species or subspecies listed as threatened or endangered by the State of Texas are also considered to have the potential to occur in the counties that border the Colorado River in the study area.

No Action

The majority of projects proposed by others within the basin would not have impacts to threatened and endangered species because most of the projects will occur in already developed or urban areas. However, there will be some loss of habitat for protected species from flood control projects, land development, mining, and continued agricultural practices in the basin. Increased water use , the construction of water supply reservoirs, and projects proposed by others that remove more surface and groundwater to meet future unmet water needs could impact several protected aquatic species that rely on adequate stream flow and groundwater recharge. The Barton Springs salamander and the Austin blind salamander, which rely on aquifer driven spring flows, are especially susceptible to these changes. No protected species occurring within Matagorda Bay would be impacted by the No Action Alternative.

Uncontrolled flood events could have impacts on interior least tern nesting sites within the basin if active nests are inundated. However, uncontrolled flood events during certain times of the year have beneficial impacts on least tern-nesting habitat by scouring and removing vegetation on sandbars. Increased development and growth within the Austin metropolitan area could indirectly impact protected migratory songbirds, such as the black-capped vireo and golden-cheeked warbler, by removing upland woody habitats they need for foraging and nesting.

Proposed Action

Coordination with the USFWS, TPWD, and NMFS would occur during project planning for the proposed alternatives. This process would minimize the potential for adverse impacts and maximize benefits to all threatened and endangered species if applicable.

All structural alternatives would have the potential to impact the bald eagle, a migrant species of the Colorado River basin. Decreases in mature forested areas would impact nesting habitat of the bald eagle. Over time, the bald eagle would benefit from any improvements to water quality and aquatic habitat due to the creation of dry detention basins, detention basins or multipurpose reservoirs if trees were established along the aquatic environment.

Impacts to the Concho water snake would potentially result from projects that occur above Lake Buchanan. The Concho water snake requires free-flowing streams with gravel or cobble substrates and is present in all counties in the Highland Lakes reach except Llano, Burnett and Travis. Structural measures that result in continuous flows and reduced sediment loads would have a positive impact to the Concho water snake while adverse impacts would result from structural measures, such as reservoirs that permanently impound water within the main stream. The Concho water snake could be impacted by a loss of habitat from the construction of dry detention basins and from decreased stream flows on the Colorado River. However, the Concho water snake could benefit from reduced sediment loads if additional sediments are trapped in the detention basins during flood events.

The black-capped vireo and golden-cheek warbler could be impacted by habitat destruction or modification from dry detention basins or multipurpose reservoirs. Multipurpose reservoirs would have a larger impact since the habitat within the footprint of the reservoir would be replaced by water.

Projects outside the recharge and contributing zone for the Edwards Aquifer would have no impacts to aquatic salamanders. The construction of levees, floodwalls, relief and diversion chan-

nels, tunnels, detention basins, and channel improvements that would occur on Onion Creek or Williamson Creek could decrease water quantity and quality of ground water by increasing sediment loads and less groundwater infiltration. This could possibly affect the Barton Springs salamander and the Austin blind salamander. Buyout and ecosystem restoration measures that restore vegetation communities and allow for more ground water recharge would benefit the aquatic salamanders that inhabit Barton Springs and cave invertebrates that occur in karst features within the Edwards and associated formations by reducing pollution loading and sedimentation into their respective habitats.

Significant elimination or disturbance to coastal marsh, tidal flats, or degradation to water quality is not expected from the implementation of the measures. Consequently, adverse impacts to the least tern, piping plover, reddish egret, white-faced ibis, whooping crane, and brown pelican would not occur. Beneficial cumulative effects could be realized from buyout and ecosystem restoration measures for all these species in the form of reduced pollutant loads, reduced sedimentation, and expansion of native vegetation.

The structural measures would not alter the current low flows within the state-listed blue sucker's habitat or impede upstream or downstream movements of the blue sucker. Consequently, the structural measures would have no impact on the state-listed blue sucker. Non-structural and ecosystem restoration measures could enhance water quality through the reduction of turbidity, sedimentation, and pollutant loads. However, these reductions would likely not be enough to benefit the species.

Impacts to the Houston toad, Texas horned lizard, timber rattlesnake, American alligator, smooth green snake, Texas scarlet snake, and the Texas tortoise are not expected from implementation of the proposed action. The Houston toad is an inhabitant of sandy uplands outside the floodplain and therefore should not be impacted from any of the project measures.

Impacts to the Navasota ladies'-tresses would not occur, as this species is not found in the type habitats where the structural and non-structural measure or the ecosystem restoration measures would occur.

No adverse impacts are anticipated to the peregrine falcon, zone-tailed hawk, swallow-tailed kite, white-tailed hawk, wood stork, Attwater's greater prairie chicken, and sooty tern from the structural measures as none of the measures would remove or substantially disturb their nesting, breeding or foraging habitat. Beneficial impacts could result for these species from buyout and

other ecosystem restoration measures by reducing pollutant loads and increasing their foraging habitat.

Direct impacts to the five species of sea turtles and the West Indian manatee are not likely, as these species do not occur in the areas where the measures would be located. Alterations in timing and quantity of freshwater flows could result in indirect impacts to these marine species if their prey base is negatively affected. Non-structural and ecosystem restoration measures would not impact these species.

4.1.12 Air Quality

No Action

Additional growth and development by private and public entities within the Austin Near Non-attainment Area have the potential to impact air quality from increased vehicle use, industrial development and construction equipment in the region.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

The use of heavy equipment during construction of any structural measure could cause a temporary and minor increase in ozone and fugitive dust levels in the area of construction. However, it is unlikely that construction activities for any of the structural measures within the Highland Lakes Reach would result in non-attainment status for the COA.

Non-Structural Measures:

The use of heavy equipment during construction of any non-structural measure could cause a temporary and minor increase in ozone and fugitive dust levels in the area of construction. However, it is unlikely that construction activities for any of the structural measures within the Highland Lakes Reach would result in non-attainment status for the COA. Zoning or gate operations changes would not have any impacts on air quality.

General Ecosystem Restoration Alternatives:

The use of heavy equipment during invasive species management and native species restoration, and removal and construction of structures could cause a temporary and minor increase in ozone and fugitive dust levels in the area of construction. However it is unlikely that these construc-

tion activities within the Highland Lakes Reach would result in non-attainment status for the COA. Although any increase in vegetated area within the basin associated with ecosystem restoration activities would provide some air quality benefits, it is unlikely that these benefits would be substantial.

4.1.13 Cultural Resources

No Action

The greatest potential for impacts to cultural resources is from projects implemented by the state and local agencies, or the private sector. Known historic and archeological sites are present near projects proposed by others and many of these sites could be impacted from project construction. Because most of those future projects would be implemented in the Austin metropolitan area, that is the area with the greatest potential for impacts to cultural resources. However, impacts to cultural resources by projects with federal sponsorship are unlikely because Section 106 of the National Historic Preservation Act (NHPA) protects all cultural resources in areas where federal projects are implemented. Conversely, projects implemented by the private sector that do not require state or federal permitting would not be required to comply with Section 106. Flood damage to sensitive historic sites, many of which are in the floodplain of the Colorado River, would continue to occur under the No Action Alternative.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

A loss of cultural resources could occur during construction of any structural measure including levees floodwalls, relief channels, diversion channels, channel improvements, tunnels, dry detention basins, detention basins, and multipurpose reservoirs; however these impacts would be fully mitigated through Section 106 consultation with the Texas State Historic Preservation Officer (SHPO) prior to construction activities. By providing localized flood protection, these structural measures could protect cultural and historic resources that would otherwise be damaged, exposed, or washed downstream during extreme flood events.

Non-Structural Measures:

A loss of cultural resources could occur during the buyout and removal of structures from the floodplain and from the alteration of structures from flood proofing measures. Flood warning systems could impact cultural resources if physical components of the systems (e.g. sirens) were placed in historic districts or within the view shed of historic structures. As with the structural alternatives, these impacts would be fully mitigated through Section 106 consultation with the Texas SHPO prior to any non-structural activities. There would be no impact to cultural resources from changes in zoning or gate operations.

General Ecosystem Restoration Alternatives:

A loss of cultural resources could occur during earthmoving activities, or structure removal or construction associated with ecosystem restoration measures. These impacts would be fully mitigated through Section 106 consultation with the SHPO prior to construction activities.

4.1.14 Recreation and Open Space

No Action

No permanent loss of recreational areas or open space from projects proposed by others under the No Action Alternative is anticipated. Recreational areas and open space within the lower Colorado River floodplain could experience a temporary loss of use from damage caused by flooding. Others (e.g. COA, LCRA) are developing additional recreational areas, particularly through projects in the Austin metropolitan area where the demand for recreation and open space is high.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Linear structural measures such as levees, floodwalls, relief channels, diversion channels and channel improvements would impact recreational resources currently existing along the affected streams through a disruption of use or a loss of area available for use (e.g. Walnut Creek, Shoal Creek, and Onion Creek). Alternatively in areas where access along streams is not currently available or is limited, levees could provide increased opportunities for recreational use (e.g. Peach Creek, Boughman Slough and Caney Creek). A reduction in the depth and frequency of large flood events would have a beneficial impact by reducing damages to existing recreational facilities and by reducing the loss of use of recreational areas currently impacted by flooding.

Dry detention basins and detention basins could provide increased recreational opportunities such as hiking, biking, hunting and wildlife viewing if the land for the basins was brought into the public domain. Alternatively, recreation opportunities could be reduced if dry detention basins and detention basins were created through flowage easements. Multipurpose reservoirs would provide several new recreational opportunities, although any existing recreational uses at the location of the reservoirs would be lost.

Non-Structural Measures:

Buyouts could provide increased recreational opportunities depending on the changes in land use for the buyout. Flood proofing, flood warning systems and zoning would not impact recreational resources. Increased flooding downstream of dams due to changes in gate operations at existing reservoirs (e.g. Lake Travis) could reduce recreational opportunities during peak flood events in the Colorado River floodplain.

General Ecosystem Restoration Alternatives:

All ecosystem restoration measures, including preservation of habitats, invasive species management and native species restoration, and the removal and construction of structures, would increase open space and the area available for recreation.

4.1.15 Hazardous, Toxic, and Radioactive Waste

No Action

Future industrial and commercial development in the lower Colorado River basin has the potential to generate hazardous, toxic, and radioactive waste (HTRW). Furthermore, refueling of equipment during all construction activities for ongoing and future projects has the potential for fuel spills. HTRW sites have been identified in the basin and projects implemented by others have the potential of being impacted by existing HTRW sites that are disturbed during construction activities. Also, hazardous, toxic and radioactive waste in the floodplain could be disturbed or distributed lateral to the stream during future flood events.

Proposed Action

General Flood Damage Reduction Alternatives:

Structural Measures:

Fuel spills associated with construction equipment and any onsite storage of fuels or lubricants could occur during construction activities for all structural measures including levees, flood-

walls, relief channels, diversion channels, channel improvements, tunnels, dry detention basins, detention basins and multipurpose reservoirs. Industrial activity in the area is relatively high and the potential exists for HTRW sites to be discovered or exposed during construction activities. Potential beneficial effects from all structural flood protection measures would include the reduced probability of HTRW being disturbed or distributed lateral to the stream during flood events.

Non-Structural Measures:

Fuel spills associated with construction equipment and any onsite storage of fuels or lubricants could occur during the removal or alteration of structures as part of buyouts or flood proofing. Potential beneficial effects from all non-structural measures would include the reduced probability of HTRW being disturbed or distributed lateral to the stream during flood events.

General Ecosystem Restoration Alternatives:

Fuel spills associated with construction equipment and any onsite storage of fuels or lubricants could occur during construction activities involved with invasive species management and native species restoration as well as the removal and construction of structures. Furthermore, there is the potential for HTRW to be discovered or exposed during any earth moving activities associated with ecosystem restoration measures.

4.1.16 Environmental Justice

No Action

Because those in poverty lack the necessary resources to recover from flood damage, continued flooding of homes, businesses and agricultural lands in the basin could disproportionately affect those in poverty. Flood damage reduction projects proposed by the COA would likely benefit people in poverty in the localized areas where flood reduction occurs. However, other proposed projects would not disproportionately affect minorities, people in poverty or children. Cumulatively, continued growth and development in the Austin metropolitan area could increase housing demands and housing prices, disproportionately affecting people in poverty, minorities and children, all of which typically suffer with rapidly rising housing costs.

Proposed Action

Structural Measures:

Acquisition of lands associated with all structural measures would be monitored closely to ensure that no specific segment of the population within the project area was disproportionately

affected. Flood damage reduction as a result of the implementation of structural measures would have beneficial impacts to minorities, people in poverty and children in the area.

Non-Structural Measures:

Buyouts and changes in zoning could disproportionately affect people in poverty and minorities and would be monitored closely to ensure that no specific segment of the population within the project area was disproportionately affected. Flood damage reduction as a result of the implementation of non-structural measures would have beneficial impacts to minorities, people in poverty and children in the area.

General Ecosystem Restoration Alternatives:

It is unlikely that ecosystem restoration measures would disproportionately affect minorities, people in poverty and children. However if acquisition of lands is required for any ecosystem restoration measure, the land purchases would be closely monitored to ensure that no specific segment of the population within the project area was disproportionately affected.

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