Preliminary Discussion Draft

Perspectives on What We Know and Don't Know:

Salient Points in Establishing a Desired Future Condition
for the Edwards Aquifer, Northern Subdivision, GMA 10,
and in Preparing a Habitat Conservation Plan
for Endangered Species Protection

1. The programs, rules and regulations of the BSEACD over the past 20+ years have and will continue to reduce groundwater pumping of the Barton Springs segment of the Edwards Aquifer -- during both non-drought and especially drought conditions -- from what would have otherwise existed as this area developed; any such regulatory program benefits the aquifer's existing users as well as Barton Springs. The aquifer's users to be protected include both humans and endangered species.

2. Dissolved oxygen (DO) of water issuing from the springs tends to be lower at lower springflows within the range of flows historically experienced. However, there is essentially no data on DO-springflow relationships in the critically important period below 15 cfs of flow; and extrapolation of this trend is not unequivocal because of the "noise" in the data; this noise indicates that the amount of springflow is just one of the factors that influence DO concentrations, and other factors may be as important with lower flow conditions.

3. The DO vs. flow relationships differ among the various spring outlets and seem to be caused by several contributing factors:
   - Their flow regimes contain more conduit vs. less conduit
   - Flows may be more turbulent vs. more laminar
   - Ambient physical/chemical conditions (algae, temperature, org. carbon) may influence DO in recharge waters
   - Contact with a subsurface atmosphere may re-aerate vs. isolated or confined water may be prevented from re-aeration.

4. Based on discussions with a USGS scientist, while many possible factors may be influencing the DO concentrations in the aquifer and in spring discharge, the DO of water in the aquifer feeding the Barton Springs complex may not drop appreciably below 4.0 mg/L under natural low-flow conditions; however, the dataset for making such judgments is limited.

5. The endangered salamander population survived not only the Drought of Record in the 1950s, when daily flows dropped to a minimum of 9.6 cfs (and monthly average flow was 11 cfs), but also other droughts in the historical and pre-historical record that were much more severe.

6. The survivability and ability of the salamander population to recover from temporary reductions in habitat quality are not just about effects on adult salamanders, but also on juveniles, reproduction, prey and predator behavior, etc.,

in a ‘weakest link’ situation, although cumulative impacts are almost certainly also important.

7. Other aspects besides the amount of pumping in the aquifer may work in antagonistic fashion to affect salamander habitat quality, including sedimentation, pooling of the spring outlets, and development in the contributing watershed that introduces oxygen-demanding materials, toxics such as pesticides and herbicides, nutrient-rich fertilizers that promote swings in aquatic growth and oxygen demand, and Barton Springs pool-related activity, among other things.

8. The mobility and inaccessibility of a significant number of individual salamanders for actual counts imply that a proxy measure of habitat condition is required for representing and protecting this endangered species population, but there is not a universal proxy that can represent all habitat impacts.

9. For purposes of both habitat conservation planning and establishment of Desired Future Conditions as required by law, the overall springflow at the Barton Springs complex is our best, if quite imperfect proxy, at least for now.

10. The University of Texas study of salamander response to variations in dissolved oxygen and conductivity was completed by Drs. Art Woods and Mary Poteet and peer-evaluated by Dr. Bryan Brooks of Baylor University. They compared metabolic rates between *E.* nana (a surrogate species from San Marcos Springs) and *E. sosorum*. Activity responses of *E. nana* to DO were quantified and assessed. In addition, experiments were performed to determine adult mortality and juvenile growth responses to DO. Further, a “probabilistic ecological hazard assessment” (PEHA) approach was used to relate threshold responses of the salamanders to DO measurements in spring habitats for the first time. The collaborative work by Woods, Poteet and Brooks is currently being published. It represents the most comprehensive understanding of adverse effects of DO on any salamander to date.

11. The HCP Biological Advisory Team (BAT) is reviewing the research by Woods, Poteet, Brooks, data collected by the City of Austin, as well as other research; and is making a series of recommendations for further study to reduce uncertainties associated with the species of concern. Future recommendations for research will be included in their final review documentation. The initial versions of neither the DFC nor HCP will be able to wait until this future research is available.

12. A prolonged DO concentration of 4.4 mg/L or above appears to be a level that will not create harm for the salamander; a prolonged DO concentration of 3.4 mg/L appears to be a level that will likely create such stress on the species that it cannot survive as a population. It is not known whether “take” is linear between these two endpoints, but laboratory studies suggest it is approximately so for the DO stressor. The behavior of salamanders and their ability to adjust to low DO stresses, such as moving into micro-environments where water velocities are

larger and therefore more oxygen is available even if in lower concentration, are conjectural and unknown. Still, the re-appearance of salamanders at the Upper Spring outlet shortly after it started flowing again after two years of no discharge in the most recent drought suggests that this behavior may be an important consideration.

13. Even during extreme drought, local rainfall events will occur from time to time and introduce oxygen-replenishing water into the aquifer; the amount of springflow and DO does not behave monotonically during prolonged drought.

14. Very recent geohydrologic studies suggest that during severe droughts, the groundwater divide between the San Antonio segment and the Barton Springs segment dissipates and water from the SA segment bypasses San Marcos Springs and discharges in the Barton Springs segment. During the most recent drought, the amount of this water was estimated to be about 5 cfs, which may represent recharge that was not completely accounted for in previous groundwater modeling of the Barton Springs segment. Conversely, the effects of flow from the Barton Springs segment to the San Marcos segment during certain non-drought and early-drought conditions may not have been completely accounted for either.

15. Probabilistic numerical simulation of springflows over a period of rainfall record extending for centuries (using regional tree-ring data), conducted recently by the TWDB, indicates that a specified amount of pumping from the aquifer may lead to springflows that vary considerably, and that such variability must be accommodated by the specification of some probability of a specific discharge resulting from a specific amount of pumpage.

16. The effects of global climate change on Central Texas will generally tend to make the weather more extreme, but will likely produce more frequent and persistent La Niña conditions, leading to hotter and drier overall conditions, which in turn would reduce springflow, other factors equal.

17. The current regulatory program of the District (absent the temporary moratorium, pending establishment of a Desired Future Condition/Managed Available Groundwater) would not restrict the total amount of water being withdrawn under permits during non-drought conditions but would completely curtail new conditional-use water withdrawals during extreme drought; and would require alternative means to address those curtailments. This interruptible-supply characteristic is a governor on new users. However, to the extent new conditional users request such permits, and even though the effect of any one such user is small relative to losses from the system due to springflows, in aggregate they tend to increase the rapidity and frequency of all users entering into drought stages, unless there is some “any-time, all-times” cap of the permitted withdrawals from the Edwards instituted.

18. From an endangered-species protection standpoint, the unknowns and the uncertainties that exist indicate that the District should be relatively conservative (toward the salamander) in establishing its groundwater management program objectives.

19. The current contentious political climate for groundwater management in Texas, surrounding the vested rights of landowners over groundwater in place, the need for more water supplies for the state, and the resistance of powerful private and public influences to regulatory restrictions on pumping for whatever reason, could increasingly limit the statutory authorities of all GCDs in the state in the future, which would reduce the BSEACD's ability to implement an effective groundwater protection program.

20. A DFC may be revised each year and must be reviewed by the Groundwater Management Area every five years to consider new information, but any *less restrictive* DFC that is the basis for a regulatory springflow program would comprise a major amendment to the HCP and Section 10(a) Permit, including NEPA review. From this standpoint, it is better to go from a less restrictive to more restrictive regulatory program over time.