BIO-WEST, Inc.

Technical Memorandum
Engineering Solutions – Biological Technical Services
Drought of Record Flow Regime Development – Task 1

Prepared for:

Edwards Aquifer Recovery Implementation Program
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SCOPE, PURPOSE, AND DELIVERABLE

Scope: BIO-WEST was charged with developing a flow regime (including assumptions) for the protection of the threatened and endangered species at Comal and San Marcos springs for a repeat of the drought of record. The goal of the regime is to not reduce the likelihood of survival of the threatened and endangered species in these two systems during a 10-year drought period similar in magnitude to the 1947 to 1956 drought of record. The preliminary drought of record flow regime presented herein will be evaluated in greater detail during Task 3 of this contract via incorporation of the flow regime into the hydrodynamic and habitat models developed for the Comal and San Marcos river systems.
Purpose: The sole purpose of this flow regime is to provide HDR engineering a starting point to evaluate how much water might be necessary via engineering solutions to protect the threatened and endangered species during a repeat of the drought of record. Task 2 of this contract involves coordination between BIO-WEST and HDR as it is anticipated that the application of the preliminary drought of record flow regime to respective engineering solutions will be an iterative process that will involve several model runs and subsequent interpretation and evaluation.
Deliverable: BIO-WEST will prepare and submit a brief memorandum to the EARIP program director describing the flow regime and associated assumptions by April 1, 2010. The following technical memorandum serves to meet the contractual Task 1 deliverable.

BACKGROUND

The Edwards Aquifer Recovery Implementation Program (EARIP) Steering Committee is served by several subcommittees, one of which is the Edwards Aquifer Area Expert Science Subcommittee (Science Subcommittee). The Senate Bill 3 J-charge tasked the Science Subcommittee with analyzing species requirements in relation to spring discharge rates and aquifer levels. The Science Subcommittee chose to address the J-charge within the context of a flow regime for the protection of all listed species as well as the integrity of each ecosystem (SSC 2009). The Science Subcommittee interpretation of a protective flow regime is one that will ensure the "survival and recovery of the species in the wild" (SSC 2009). To accomplish this goal, the Science Subcommittee determined that the recommended flow regime must sustain an overall trend of maintaining or increasing the populations of the threatened and endangered species (SSC 2009).

As part of the Engineering Solutions study being conducted by HDR engineering, BIO-WEST was asked to develop a flow regime designed to keep the threatened and endangered species of the Comal and San Marcos systems alive during a 10-year severe drought (similar in nature to the 1950s drought of record) with the potential for recovery following that event. As such, the goal of this exercise is very different from the Science Subcommittee's J-charge. The J-charge goal was to ensure the "survival and recovery of the species in the wild" which was defined as supporting an "overall trend of maintaining or increasing the populations of the threatened and endangered species." The goal of this exercise is to ensure "survival" of the threatened and endangered species with the "potential for recovery" once the drought ends. Under this scenario, conditions will likely not be favorable for the species most of the time. In fact, it is likely that populations will decline during this severe drought period, habitat quality and quantity will be considerably reduced, and reproduction of the species might be limited to non-existent during portions of any given year.

Thus, this preliminary drought of record (DoR) flow regime is not meant to replace the Science Subcommittee's J-charge recommendations in any manner. The two regimes have been developed for different purposes with different goals. As the goal of the preliminary DoR flow regime is survival of the species with the potential for recovery when the drought is over, this regime is not meant to be applied to periods shorter or longer than the 10-year repeat of the drought condition for which it was developed.

INTRODUCTION

The focus of this assessment is on threatened and endangered species inhabiting Comal and San Marcos springs that directly rely on spring discharge. For the surface-dwelling species, such as the fountain darter, San Marcos salamander, Texas wild-rice, and Comal Springs riffle beetle, some amount of springflow is necessary for survival, and thus they are included for consideration in this assessment. For the aquifer-dwelling listed species such as the Texas blind salamander, Peck's cave amphipod, and Comal Springs dryopid beetle, it is assumed in this exercise that maintaining the same amount of discharge needed for the protection of surface dwelling species would protect these species also, and thus they are not directly considered in this assessment.

Comal Species and Historical Discharge

Fountain darters were collected for the first time in the Comal River in 1891. The last collection of fountain darters in the Comal River before its apparent extirpation was 1954. Whiteside and Schenck released 457 adult fountain darters, collected from the San Marcos River (mostly from below Rio Vista Dam), into the Comal system from February 1975 through March 1976. A reproducing population has been reestablished and is now found throughout the Comal aquatic ecosystem from Landa Lake to the vicinity of the Comal/Guadalupe River confluence.

Comal Springs riffle beetles are found in areas where springflow is evident around Landa Lake in the Comal River. This includes spring runs, spring openings associated with shoreline habitat, and upwelling areas surrounding Spring Island and in deeper portions of the lake. One of the primary flow-related questions is associated with the survival of the Comal Springs riffle beetle during the drought of the 1950s. No information is available to indicate how the species survived this period of prolonged drought and approximately five months of zero flow. A detailed discussion on this topic is presented in the Science Subcommittee J-charge report (SSC 2009).

The average discharge at Comal Springs during the period of record from 1927 to 2009 was approximately 291 cubic feet per second (cfs). The minimum recorded flow was zero when the springs stopped flowing for 144 consecutive days in 1956. This extreme flow condition coupled with the likelihood that this event led to the extirpation of the fountain darter is considered beyond the point of severe risk for the fountain darter. Although all other endangered species were assumed to persist through this period, there is no evidence as to the state of health of any of these populations immediately following that event which provides an unknown relative to whether they would persist if those conditions were repeated.

Another historic period that is biologically meaningful for the Comal Springs system is the period of time since the fountain darter has been re-introduced into Comal Springs (post-1975). Sustained current populations suggest that this period has been favorable for the fountain darter. It is important to note that spring discharge in the Comal system in 1984 went below 60 cfs for over 100 consecutive days and below 40 cfs for over 40 consecutive days (dropping down to 26 cfs. Since 1975, diminished flows at Comal Springs have occurred in 1984 (26 cfs), 1989 (62 cfs), 1990 (46 cfs), and 1996 (83 cfs) with continued survival of the fountain darter, Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's Cave amphipod.

San Marcos Species and Historical Discharge

Fountain darters were first collected in the San Marcos River in 1884 from immediately below the confluence with the Blanco River. The present distribution of fountain darters in the San Marcos River is from Spring Lake to an area between the San Marcos wastewater treatment plant outfall and the confluence with the Blanco River. San Marcos salamanders are found throughout Spring Lake (at the headwaters of the San Marcos River) where rocks are associated with spring openings and in rocky areas up to 150 meters below Spring Lake Dam. Comal Springs riffle beetles are found in upwelling areas within Spring Lake.

Texas wild-rice was first collected in the San Marcos River in 1892. When the species was originally described it was reported to be abundant in the San Marcos River, including Spring Lake and its irrigation waterways (Silveus 1933). By 1967, only one plant remained in Spring Lake, no plants were found in the uppermost 0.8 kilometers (0.5 miles) of the San Marcos River, only scattered plants in the lower 2.4 kilometers (1.5 miles), and none below that (Emery 1967). In 1976 Emery began monitoring the coverage of Texas wild-rice within the San Marcos River on a regular basis. Currently Texas wild-rice occurs in the upper 2.4 kilometers of the San Marcos River, above the confluence with the Blanco River and maintains approximately 3,300 m^2 of areal coverage (BIO-WEST 2010).

The average discharge at San Marcos Springs during the period of record from 1940 to 2009 was approximately 164 cfs. The minimum recorded flow was 46 cfs during August 1956. The minimum monthly average springflow of approximately 54 cfs also occurred during that month. For an 18-month period (September 1955 through February 1957), monthly average springflow was approximately 69 cfs and ranged from 77 cfs (September 1955) to 54 cfs (August 1956). While all the listed San Marcos species (with the exception of the Comal Springs riffle beetle and the San Marcos Gambusia) were known from the San Marcos ecosystem before and after the extreme low flow conditions of the 1950s, there is no evidence as to the size, distribution, or health of any of their populations immediately prior to or after that extended event.

ASSUMPTIONS

During the development of the preliminary DoR flow regime, several key assumptions were made as follows:

- a 10-year time period was associated with the DoR for this exercise. It is likely that shorter time periods may require less water or different inter- and intra-annual strategies to maintain the same goals, while longer periods would likely require a different overall strategy involving additional mitigation and management.
- focus was placed on surface dwelling species (fountain darter, Comal Springs riffle beetle, Texas wild-rice, and San Marcos salamander),
- Edwards Aquifer water quality will be maintained by the minimum monthly springflows recommended at Comal and San Marcos springs, and thus subterranean species will be protected,
- water quality of the spring flow will have the same chemistry and biological components as Edwards Aquifer water,
- mitigation and management activities will take care of exotic plant and animal species including the gill parasite,
- recreational impacts to species will be addressed and managed to limit impact,
- Intensive Management Areas (IMAs) are in place on both the Comal and San Marcos systems, and
- a management strategy is in place to address the flow split between the new and old channels at Comal Springs.

There was no attempt to justify any of these assumptions within this document, but rather these assumptions were used as a starting point to accomplish the goal of determining a volume of water over a 10-year severe drought period necessary to protect the threatened and endangered species via potential engineering solutions. Refinements to both the flow regime and assumptions are likely as subsequent tasks under this contract are completed.

KEY CRITERIA

In the development of the DoR flow regime for both systems, key criteria focused on:

1. maintaining quality habitat throughout a portion of the species range at all times, and
2. maintaining reproduction of the species annually, at a minimum.

It is anticipated that in achieving these key criteria in collaboration with the assumptions described above, the species could survive a severe drought with the potential for recovery. Again, considerable areas of habitat may be lost and populations most likely will decline through this period, but the ultimate goal is survival with the potential for recovery.

For ***Comal Springs***, the following criteria were evaluated for the fountain darter and Comal Springs riffle beetle:

- Fountain darter
    - Maintain quality habitat through a portion of Landa Lake and the Old Channel at all times.

    - Maintain quality habitat in the New Channel most of the time.
    - Maintain seasonal (Spring) reproduction in Landa Lake, Old Channel and New Channel on an annual basis.
    - Maintain year round reproduction in Landa Lake and the Old channel during intermediate and pulse years.
    - IMA established in Old Channel during summer time months of low flow years.
- Comal Springs riffle beetle
    - Maintain quality habitat through a portion of Landa Lake, Spring Island area, and western shoreline at all times.
    - Maintain quality habitat in Spring run 3 most of the time.
    - IMA established in Spring run 3 during summer time months of low flow years.

For ***San Marcos Springs***, the following criteria were evaluated for the fountain darter, Texas wild-rice, San Marcos salamander and Comal Springs riffle beetle:

- Fountain darter
    - Maintain quality habitat through a portion of Spring Lake and subsequent river channel above I35 at all times.
    - Maintain quality habitat in the full longitudinal extent of darter occupied habitat most of the time.
    - Maintain seasonal (Spring) reproduction in Spring Lake and entire river channel annually.
    - Maintain year round reproduction in Spring Lake and eastern spillway IMA during most years.
- Texas wild-rice
    - Maintain some quality habitat in river channel down to I35.
    - IMA established in the eastern spillway below Spring Lake Dam and maintain high quality habitat in this area at all times.
    - IMAs established longitudinally down the San Marcos River to provide deeper flowing habitat areas during low flow years.
    - Prevent recreation from causing any effects in designated IMA protection areas.
- San Marcos salamander
    - Maintain quality habitat through a portion of Spring Lake and subsequent river channel to University Drive at all times.
    - Maintain seasonal (Spring) reproduction in Spring Lake and subsequent river channel to University Drive at all times.
    - IMA established in the eastern spillway below Spring Lake Dam and maintain high quality habitat in this area at all times.
    - Maintain year round reproduction in Spring Lake and eastern spillway IMA during most years.
- Comal Springs riffle beetle
    - Maintain quality habitat through a portion of Spring Lake at all times.

DROUGHT OF RECORD (DoR) FLOW REGIME

As described in both Science Subcommittee reports (SSC 2008 and 2009), a flow regime rather than a single minimum number is critically important to the health of an ecosystem. This flow regime concept also applies during severe conditions, in that holding the Comal or San Marcos springs constant at some discharge over an extended period of time will not be protective of the species regardless of the quantity of water prescribed. As such, inter- and intra-year flow regime components were developed for a 10-year severe drought for both the Comal and San Marcos springs systems. An example of this flow regime is provided in Figure 1.

Figure 1 shows that during any given year the flow will vary from lower summertime conditions to higher spring time conditions. Additionally, an intra-annual pattern of Low, Intermediate and Pulse years were included in the regime to enhance the protection of the species. The inter-annual pattern attempts to mimic conditions over the period of record with some adjustment. For instance, winter flows were reduced in these recommendations compared to historical flows because habitat conditions are assumed to be maintained during the winter period without necessarily the same volume of water as experienced historically. Conversely, proposed flows during the spring were slightly increased above historically observed patterns during the lowest years to ensure conditions suitable for annual reproduction of the species. The intra-annual pattern was imposed to break up the duration of the Low years with Intermediate and Pulse years in order to provide some relief to the species and their habitat during a 10-year extended drought.

Comal Springs

Table 1 and Figure 2 show the preliminary DoR flow regime as prescribed for Comal Springs. Low years range from 30 to 80 cfs, Intermediate years range from 75 to 110 cfs, and Pulse years range from 80 to 120 cfs. Figures 3 and 4 show the flow conditions for the New Channel and Old Channel under the proposed DoR flow regime. Overall, the proposed regime with embedded assumptions is anticipated to meet the two key criteria outlined above (maintaining quality habitat throughout a portion of the species range at all times and ensuring annual reproduction of the species at a minimum) as well as the Comal species-specific criteria evaluated. The two key areas for the Comal Springs system will be Landa Lake and the Old Channel. Meeting the two key criteria and focusing on Landa Lake and the Old Channel does not ensure that conditions will be favorable for the Comal species throughout their range for the entire 10-year period. In fact, this DoR flow regime does not provide spring flow in the Upper Spring Run Reach above Spring Island. It is anticipated that this area will quickly become unsuitable for fountain darters (no Comal Springs riffle beetles currently inhabit this area), and unless periodic rainfall causes some flow, conditions will remain unfavorable throughout the 10-year period.

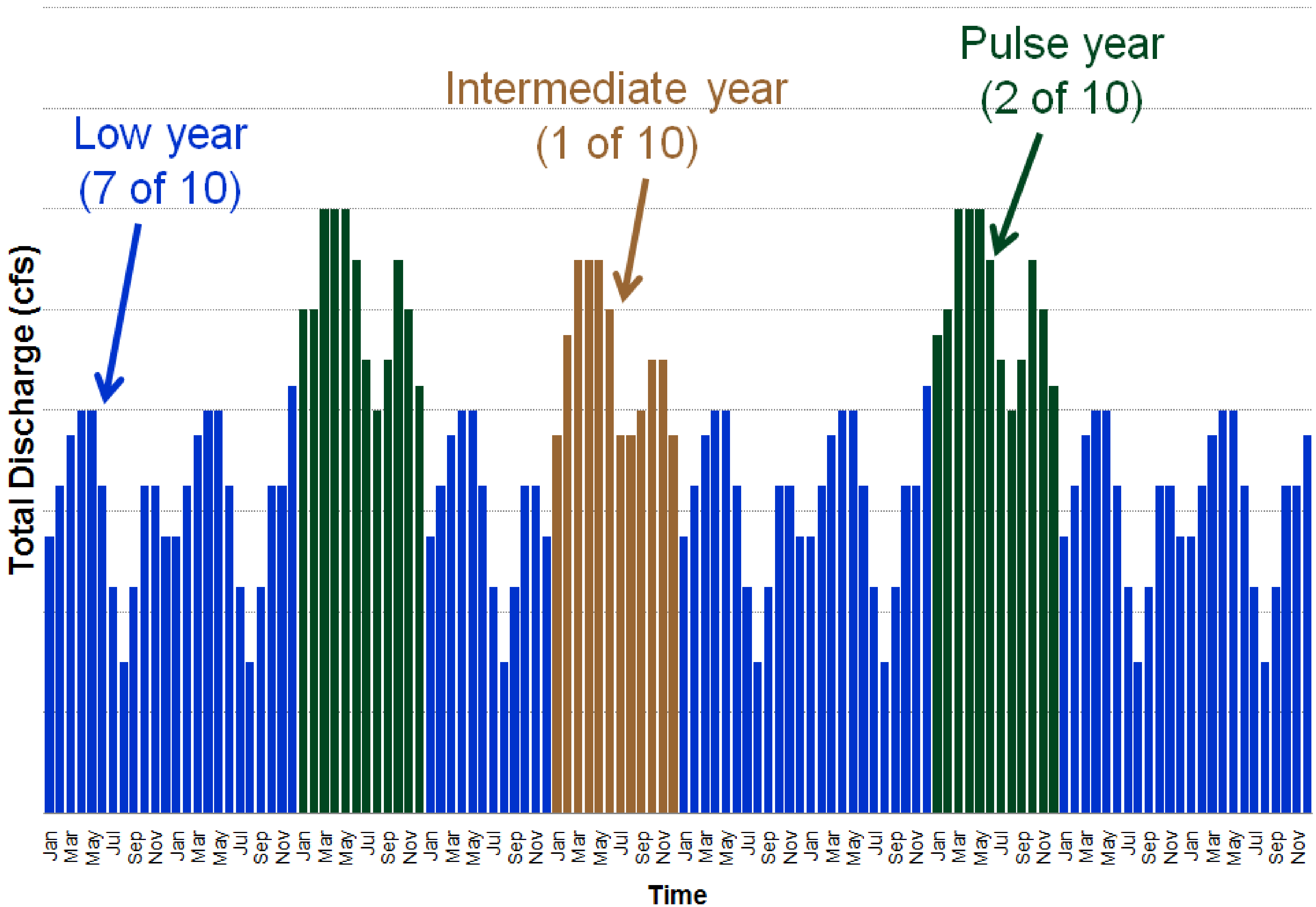

Figure 1. 10-year DoR Flow Regime Example

Table 1. Comal Springs DoR Flow Regime. Low, Intermediate (Int.), and Pulse years.

	Comal Springs - Monthly Flow (cfs) per year									
	Year 1 (Low)	Year 2 (Low)	Year 3 (Pulse)	Year 4 (Low)	Year 5 (Int.)	Year 6 (Low)	Year 7 (Low)	Year 8 (Pulse)	Year 9 (Low)	Year 10 (Low)
Jan	55	55	100	55	75	55	55	95	55	55
Feb	65	65	100	65	95	65	65	100	65	65
Mar	75	75	120	75	110	75	75	120	75	75
Apr	80	80	120	80	110	80	80	120	80	80
May	80	80	120	80	110	80	80	120	80	80
Jun	65	65	110	65	100	65	65	110	65	65
Jul	45	45	90	45	75	45	45	90	45	45
Aug	30	30	80	30	75	30	30	80	30	30
Sep	45	45	90	45	80	45	45	90	45	45
Oct	65	65	110	65	90	65	65	110	65	65
Nov	65	65	100	65	90	65	65	100	65	65
Dec	55	85	85	55	75	55	85	85	55	75

From an intra-annual perspective, conditions in the New Channel (Figure 3) will be variable with fountain darter habitat likely being supported during Pulse and Intermediate years, but very limited during Low years. It is anticipated that quality habitat would remain in portions of Landa Lake and the Old Channel during all three year types. The amount of and level of quality of that habitat is what would likely shift between years. Figure 4 shows the proposed flow regime for the Old Channel with the red bars indicating times when the Old Channel IMA would be in operation. The Old Channel IMA operation associated with the proposed DoR flow regime consists of up to 15 cfs being recycled in the upper portion of the Old Channel when total discharge declines below 40 cfs. This recirculation would allow 35 to 40 cfs to remain in the IMA area of the Old Channel while still sending 10 cfs to the New Channel during those months. This would provide for the maintenance of habitat in the Old Channel IMA during short periods (three months) of Low years and still provide flow to the New Channel. There are several unknowns associated with a potential IMA that are not discussed in this document as this is the subject of a separate EARIP sponsored project. For this DoR flow regime development, an Old Channel IMA is assumed to be implemented and effective in maintaining some fountain darter habitat during these short periods of Low years.

From an inter-year perspective, flows during Low years are anticipated to be supportive of quality habitat and water temperature conditions for the fountain darter throughout the central portions of Landa Lake and the upper stretch of the Old Channel. These conditions should be amenable to spring time reproduction for the fountain darter at these locations. During Low years, habitat conditions for the Comal Springs riffle beetle would be limited to the upwelling areas around Spring Island, the western shoreline of Landa Lake, and upwelling areas in the deeper portions of the lake most of the year, and in Spring Run 3 during the spring. Spring Runs 1 and 2 would likely exhibit limited to no surface flow during Low years. During Intermediate and Pulse years, the amount of habitat is anticipated to expand, respectively, and likewise the quality of habitat is expected to improve.

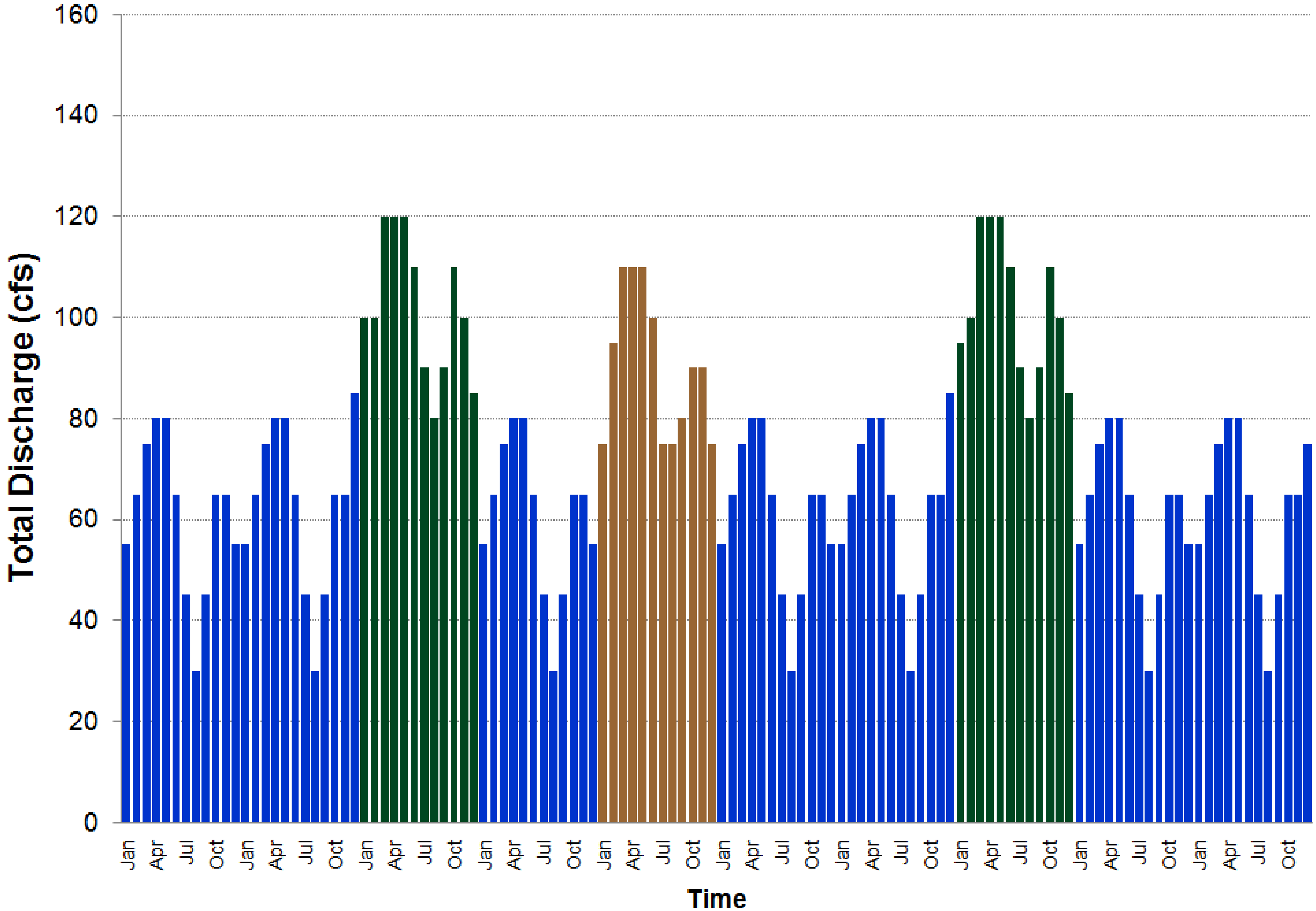

Figure 2. Comal Springs - 10-year DoR Flow Regime. Low years (Blue), Intermediate (Brown), Pulse (Green)

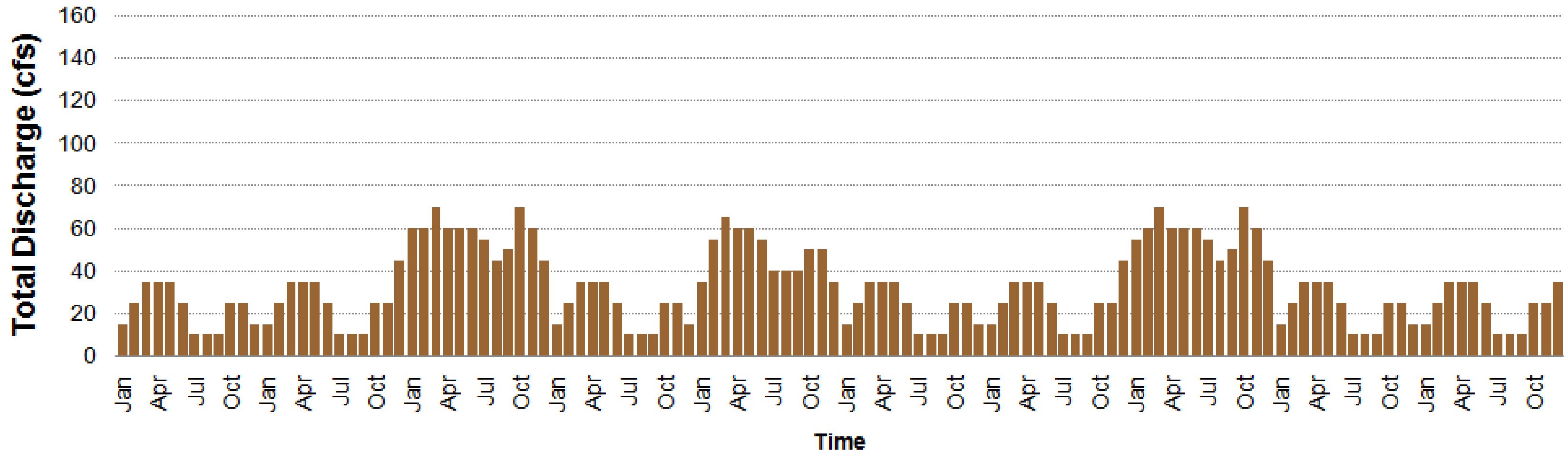

Figure 3. New Channel Flow Distribution - 10-year DoR Flow Regime Comal Springs

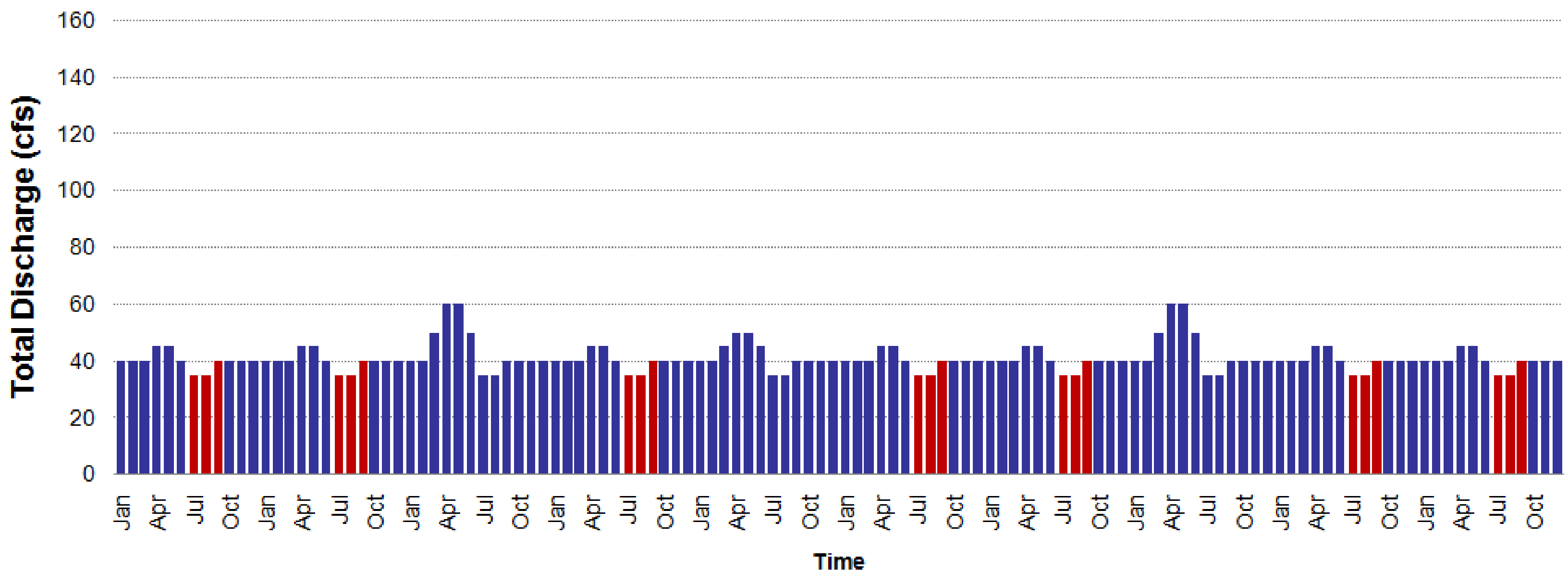

Figure 4. Old Channel Flow Distribution - 10-year DoR Flow Regime Comal Springs. Red bars signify Old Channel IMA is in operation.

The goals during the Pulse years are to provide year-round reproduction for fountain darters in Landa Lake and the Old Channel, seasonal fountain darter reproduction in other areas including the New Channel, and ensure surface flow in Spring Run 3 throughout the year for the Comal Springs riffle beetle.

It is important to reiterate that the purpose of this exercise is to provide a starting point for water volume calculations for HDR's engineering solutions study. However, it should also be stated that although considerable evaluation of best available information was used to develop the proposed DoR flow regime, a high level of professional judgment is also involved, and many unknowns still exist even beyond the assumptions listed. For example, how the aquatic vegetation in the Comal System responds to extended periods of lower than average flow is a major unknown. Should massive die-offs of vegetation occur throughout Landa Lake during these extended periods, the proposed DoR flow regime might need considerable refinement. If water temperatures could not be maintained as predicted by current water quality models or the Old Channel IMA be proven unfeasible or ineffective, refinements would also likely be necessary. In contrast, should aquatic vegetation be more tolerable than anticipated, water temperatures remain suitable beyond what was predicted by modeling, and/or the Old Channel IMA is more effective than anticipated, a downward shift in the regime might be possible. These are just a few of the factors that will be evaluated for the Comal system during the subsequent tasks for this project.

San Marcos Springs

Table 2 and Figure 5 show the preliminary DoR flow regime as prescribed for San Marcos Springs. Low years range from 40 to 70 cfs, Intermediate years range from 65 to 80 cfs, and Pulse years range from 65 to 100 cfs. Overall, the proposed DoR flow regime with embedded assumptions is anticipated to meet the two key criteria outlined above (maintaining quality habitat throughout a portion of the species range at all times and ensuring annual reproduction of the species at a minimum) as well as the San Marcos species-specific criteria evaluated. The three key areas for the San Marcos Springs system will be Spring Lake, the eastern spillway below Spring Lake dam, and the San Marcos River above I-35. However, meeting the two key criteria and focusing on these areas does not ensure that conditions will be favorable for the San Marcos species throughout their range for the entire 10-year period. A major concern with this regime is the potential effect on Texas wild-rice. Without considerable mitigation and management (which are key assumptions for Texas wild-rice), this DoR flow regime may not meet the goal of potential for recovery for this species. However, for the purpose of this exercise the assumptions presented above are in place and mitigation and management are deemed effective.

From an intra-annual perspective, it is anticipated that quality fountain darter habitat would remain in portions of Spring Lake and the San Marcos River above I-35 during all three year types. The amount of and level of quality of that habitat is what would likely shift between years. Similarly, it is anticipated that quality habitat would remain in portions of Spring Lake for the San Marcos salamander and Comal Springs riffle beetle during all three year types. With the eastern spillway IMA in operation, it is anticipated that quality habitat would remain for the San Marcos salamander and Texas wild-rice in the eastern spillway during all three year types. It is also anticipated that the deeper areas of Sewell Park would provide quality habitat for Texas wild-rice during all three year types. The major question is what will happen to Texas wild-rice in downstream areas under the proposed DoR flow regime.

Table 2. San Marcos Springs DoR Flow Regime. Low, Intermediate (Int.), and Pulse years.

	San Marcos Springs - Monthly Flow (cfs) per year									
	Year 1 (Low)	Year 2 (Low)	Year 3 (Pulse)	Year 4 (Low)	Year 5 (Int.)	Year 6 (Low)	Year 7 (Low)	Year 8 (Pulse)	Year 9 (Int.)	Year 10 (Low)
Jan	50	50	75	50	65	50	50	75	65	50
Feb	60	60	90	60	75	60	60	90	75	60
Mar	70	70	100	70	80	70	70	100	80	70
Apr	70	70	100	70	80	70	70	100	80	70
May	70	70	100	70	80	70	70	100	80	70
Jun	70	70	100	70	80	70	70	100	80	70
Jul	60	60	100	60	75	60	60	100	75	60
Aug	45	45	90	45	60	45	45	90	60	45
Sep	40	40	90	40	60	40	40	90	60	40
Oct	60	60	80	60	75	60	60	80	75	60
Nov	60	60	80	60	75	60	60	80	75	60
Dec	50	50	65	50	65	50	50	65	65	50

Based on habitat modeling of existing conditions and evaluations of currently occupied areas, it is likely that large expanses of Texas wild-rice would be negatively affected by the proposed DoR flow regime without considerable mitigation and management activities. Therefore, the assumptions of implemented and effective IMAs located longitudinally down the San Marcos river, along with control of recreation are important to the proposed DoR flow regime meeting the goal of potential for recovery for all species. Texas wild-rice would likely survive in the eastern spillway and deeper portions of Sewell Park without these longitudinal IMAs, but the potential loss of genetics by a large reduction in areal coverage of Texas wild-rice is currently unknown. As previously stated there are many unknowns associated with potential IMAs that won’t be discussed in this document as this is the subject of a separate EARIP sponsored project. Compared to the Comal system, a second Intermediate year was added to the San Marcos DoR flow regime because of the unknowns specifically surrounding Texas wild-rice.

From an inter-year perspective, flows during Low years are anticipated to be supportive of quality habitat and water temperature conditions for the fountain darter throughout the main body of Spring Lake and the river down to near I-35. These conditions should be amenable to spring time if not year-round reproduction for the fountain darter in these areas. During Low years, habitat conditions for the San Marcos Salamander and Comal Springs riffle beetle would be limited to the upwelling areas in the main body of Spring Lake and the eastern spillway. During Intermediate and Pulse years, the amount of habitat for all species is anticipated to expand, respectively, and likewise the quality of habitat is expected to improve. The goals during the Pulse years are to provide year-round reproduction for fountain darters in Spring Lake and the entire occupied stretch of the San Marcos River and provide improved conditions for the San Marcos salamander, Comal Springs riffle beetle, and Texas wild-rice.

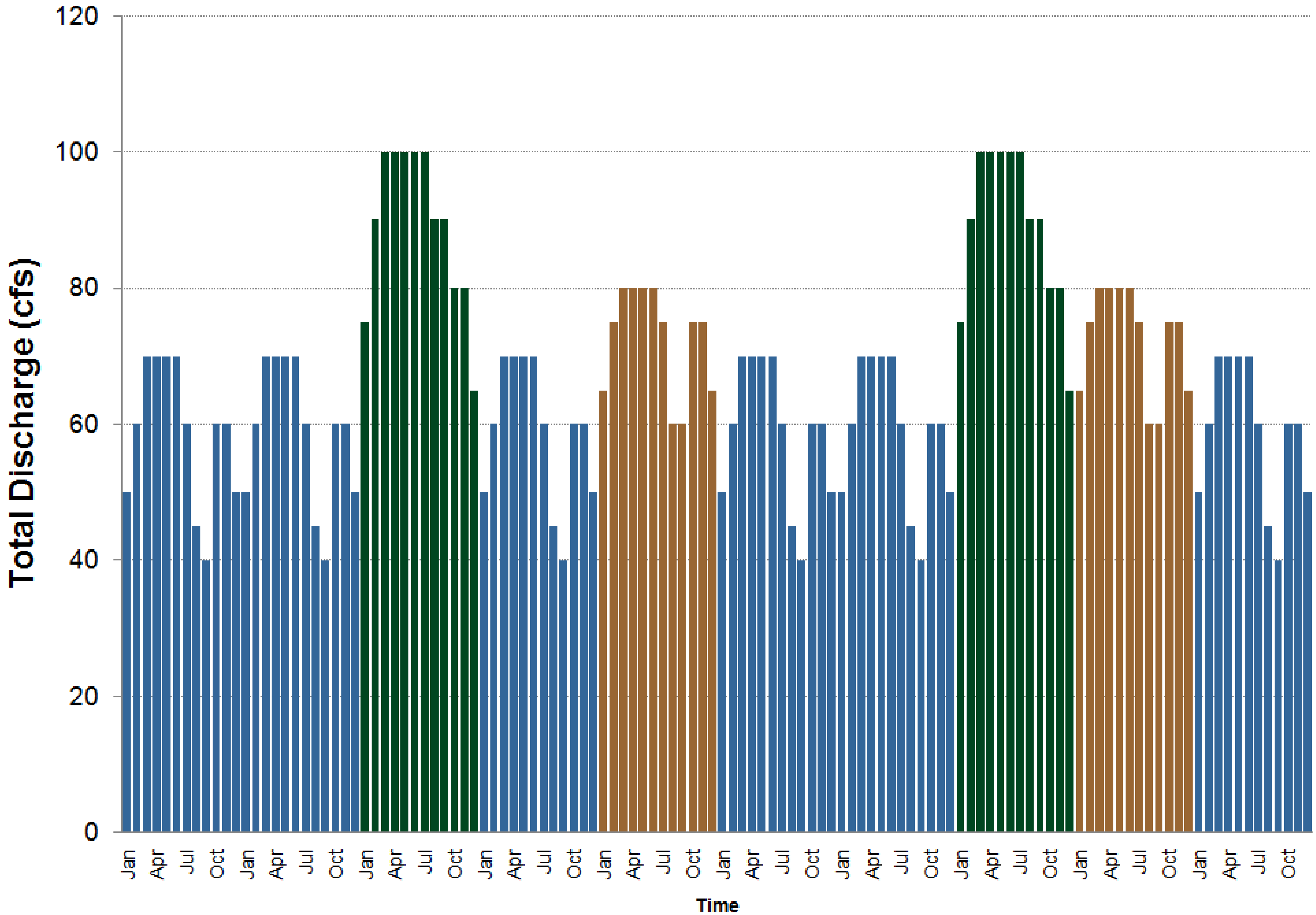

Figure 5. San Marcos Springs - 10-year DoR Flow Regime. Low years (Blue), Intermediate (Brown), Pulse (Green)

As previously stated, it is important to understand that the purpose of this exercise is to provide a starting point for water volume calculations for HDR's engineering solutions study. However, as with the Comal system, it needs to be clear that there are many unknowns regarding long durations of low flow for the San Marcos system. As such, additional work will be conducted during subsequent tasks of this contract to try and answer some of those questions, or at least inform the EARIP of the potential for risk associated with some of these unknowns.

NEXT STEPS

Task 2: Engineering Solutions coordination and evaluation

Scope: BIO-WEST will coordinate with HDR to evaluate the engineering and economic feasibility of potential engineering solutions. This coordination will take place during the development and evaluation of engineering solutions necessary to provide the quantity and quality of water necessary to accomplish the proposed DoR flow regime. It is anticipated that the application of the proposed flow regime to respective engineering solutions will be an iterative process that will involve several model runs or calculations by HDR. BIO-WEST will provide guidance to the degree applicable on input parameterization of necessary model runs or calculations and also participate in the biological interpretation of the output from those runs. A major question to be addressed is when would the DoR flow regime be triggered and how the engineering solutions ensure the quantity of water necessary to meet the flow recommendations.
Deliverable: BIO-WEST does not have a deliverable for this task. Activities will include internal coordination and biological technical assistance provided to HDR to evaluate the feasibility of various engineering solutions.

Task 3: Aquatic Vegetation modeling coordination and interpretation

Scope: BIO-WEST will coordinate with Dr. Thom Hardy of the River Systems Institute at Texas State University during his development of an aquatic vegetation module to his existing hydrodynamic models for both the Comal and San Marcos systems. Results from the model runs will inform our understanding of the response of water quality and aquatic vegetation during extended low flow conditions. This exercise may provide a higher level of confidence that the proposed DoR flow regime or modified regime will meet the goal of being protective during a 10-year severe drought condition. The modification of the preliminary DoR flow regime based on these results may also be an iterative process as this information may require considerable shifts in the flow regime presented in this memorandum.
Deliverable: BIO-WEST will prepare a technical memorandum describing the results of model runs incorporating the preliminary DoR flow regime and any modifications to the original flow regime that may be required. The technical memorandum will be submitted to the EARIP program director.

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