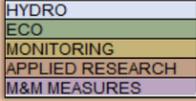


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Research Priorities Moving Forward 	Some specific applied research foci are especially important given the HCP's management objectives.	1	The 2017 project to establish better relationships between the fountain darter and the different species and coverages of submerged aquatic vegetation (including Ludwigia) in both systems is critically important.	General agreement; Population studies should try to include all species, not just the Comal Springs riffle beetle, for use as a baseline (using an empirical model)	Done and may potentially be examined further through future Applied Research.	No	Yes, with the caveat that budget only extends until 2019.	Yes	To be conducted through the Refugia research program.	1. Research to be conducted in 2018 and 2019 was established by the 2017 Research Work Group. Generally, this list is more comprehensive than what has been provided by NAS; 2. 2018 and 2019 are the last two years of Applied Research.
		2	Research to better understand the life history of listed species and identifying effective sampling techniques rightfully deserves high priority.		Yes	No	Yes, with the caveat that budget only extends until 2019.	Yes		
Application and Limitations to Application for Existing Applied Research Results	Applied research study results can and should be used to inform management efforts; in some cases, caution is warranted in applying these results, however.	3	The Comal Springs riffle beetle temp and oxygen study's use of surrogates is of questionable relevance for the Comal Springs riffle beetle.	General agreement, and the following specific comments: The Spring Communities should: maintain focus on planting and using native plant species in both systems; promote native plant species for restoration but not to the detriment of surrounding species.	No action required	No	Yes, with the caveat that budget only extends until 2019.	Yes	HCP staff agrees with this comment.	
		4	The Comal Springs riffle beetle temp and oxygen study's use of lab environments may not provide a relevant test of Comal Springs riffle beetle behavior in its natural environment.		No action required	No	Yes, with the caveat that budget only extends until 2019.	Yes	HCP staff agrees with this comment.	
		5	Areas where Hygrophylla is of concern should be targeted for Ludwigia establishment where restoration efforts are being carried out.		In process	No	Yes, with the caveat that budget only extends until 2019.	Yes	This recommendation is available to NB and SM/TXSTATE for consideration as they implement the submerged aquatic vegetation schedule/regime established through AMP; City of New Braunfels already doing this.	
		6	The competitive advantage of Ludwigia against Hygrophylla should be communicated to the submerged aquatic vegetation modeling team and incorporated into their efforts.		Done	No	Yes, with the caveat that budget only extends until 2019.	Yes	The submerged aquatic vegetation research was conducted by members of the modeling team.	
		7	Additional consideration of the interactions between Hydrilla and Ludwigia is needed before conclusions are made or further application of this research occurs.		In process	No	Yes, with the caveat that budget only extends until 2019.	Yes	HCP staff agrees with this comment.	
		8	Ludwigia should be seriously considered for use in the San Marcos system.		In process	No	Yes, with the caveat that budget only extends until 2019.	Yes	This recommendation will be made available to SM/TXSTATE for consideration as they implement the submerged aquatic vegetation schedule/regime established through AMP	
		9	miniDOT oxygen sensors in Landa Lake and Upper Spring Run should be continued as part of a routine integrated water quality and biological monitoring program		Yes	No	Yes, with the caveat that budget only extends until 2019.	Yes	EAHCP added a sonde to Landa Lake; CONB plans to add through 2018 Work Plans (not yet approved).	

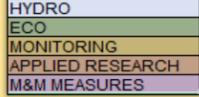
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		10	The Committee recommends that aeration not be used routinely as a mitigation measure.		TBD through Landa Lake DO Mgmt. Plan under development.	No	Yes, with the caveat that budget only extends until 2019.	Yes	NB is currently conducting research to establish a DO Mgmt. Plan for Landa Lake; may pursue AMP next year.	
Comal Springs riffle beetle Population and Sampling Techniques	Several issues remain to be addressed with regards to Comal Springs riffle beetle population and sampling.	11	There should be a method to provide standardized data that accounts for the amount of time that the cotton lure has been deployed.	General agreement, and the following specific comments: A study looking Comal Springs riffle beetle population abundance using a model that incorporated the entire system, not just the sample reached identified in the HCP; • Ensure continued use and implementation of a Comal Springs riffle beetle sampling Standard Operating Procedure; • A large scale population/abundance study on Comal Springs riffle beetle is needed.	Done	No	Yes, with the caveat that budget only extends until 2019.	Yes	Done through the 2016 Comal Springs riffle beetle Cotton Lure SOP Work Group	
		12	The Comal Springs riffle beetle trophic study should be looked at with a view to possibly identifying an alternative sampling approach for the Comal Springs riffle beetle that could be a reasonable reflection of population densities.		No; done.	No	Yes, with the caveat that budget only extends until 2019.	Yes	The trophic study was completed in July 2017. It investigated trophic ecology of the riffle beetle and did not directly look into sampling methodology.	
		13	Identifying the type, and estimate the relative amount, of organic matter near or at the cotton lure placement locations should be included as part of the cotton-lure SOP for Comal Springs riffle beetle.		Done	No	Yes, with the caveat that budget only extends until 2019.	Yes	Done through the 2016 Comal Springs riffle beetle Cotton Lure SOP Work Group (EAHCP, 2016).	
		14	A validation study encompassing repeated sampling from the same and new spring outlets to account for potential life history and flow effects on the population estimates is highly recommended.		Done	No	No	Yes	Data from the new database and other sampling entities would have to be compiled and examined.	
		15	Studies on the importance of Peck's cave amphipod-predation on the Comal Springs riffle beetle may be warranted.		No	No	Yes, with the caveat that budget only extends until 2019.	Yes	It is understood that the amphipod is a predator, however, this project is not a priority at this time.	
		16	Key lab experiments involving the Comal Springs riffle beetle (e.g., connectivity study) should be validated using creative field studies where variables can be manipulated.		No	No	No	?	The HCP has a current and ongoing research program on the Comal Springs riffle beetle that is not yet finished; other field studies have been conducted by outside researchers as well.	
		17	<i>Attempts to understand the population abundances of the Comal Springs riffle beetle should be undertaken.</i>		TBD	No	Yes, with the caveat that budget only extends until 2019.	Yes	EAA, the Science Committee, and TPWD are looking into these projects; caution is urged concerning scope creep and precedent-setting nature of HCP undertaking some of these projects. May be limited to only those beetles at the	The HCP is not required to produce population estimates of the Comal Springs riffle beetle. Rather the HCP is required to produce "take" estimates. 7 Comal Springs riffle beetle studies have been conducted to date. In addition,

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		18	Attempts to better quantify the Comal Springs riffle beetle population densities should be undertaken.		TBD	No	Yes, with the caveat that budget only extends until 2019.	Yes	surface (rather than having any subterranean component).	an SOP has been established to standardize and enhance cotton lure methodology used by various researchers in the region.
		19	Attempts to better calibrate the cotton-lure method of sampling to be efficient and reliable for estimating populations should be made.		TBD	No	Yes, with the caveat that budget only extends until 2019.	Yes		
Administrative/Logistical Considerations Associated with the Applied Research Program	There are several administrative and/or logistical considerations that should be considered for the improvement of the Applied Research program.	20	The window of time for an RFP to be open to final deadline should be extended.	General agreement and the following specific comments: • The EAA should make changes to the procurement process to attract academic institutions by allowing longer response times to RFPs, creating multi-year contracts, reducing specifications regarding invoicing, payments, reporting, and deliverables; • EAA should develop a method to access and fund MS and PhD students to conduct research in the springs, thereby training new scientists familiar with the springs and creating more data from their research; • Request a reduction of overhead/indirect costs to make it more affordable to work with universities; • There should be a way to try to integrate new data with existing data.	Done	No	Yes	Yes	The time period will be extended from 3 weeks to 8 weeks for 2018/2019 RFPs.	
		21	The EAA should continue to look for ways to remove conditions that restrict the pool of potential Applied Research applicants.		Done - continual	No	Yes	Yes	See comments.	Efforts have been made to greatly increase the distribution of RFPs to the scientific community; efforts are being made to extend the application window (see #20); the program is entering Y2 of its first ever two-year project (BIO-WEST, Inc., 2016).
		22	The EAA should use the data management system being implemented to allow greater data discovery and access by the outside scientific community and the public.		Yes	No	No	Yes	Currently there are no plans or resources to make the database accessible online. However, EAA is committed to providing all data when requested.	
		23	The cause for the large mortalities of Comal Springs riffle beetle at the FAB still need to be definitively identified and resolved through additional study.		Done	No	No	No		There have been no issues since additional precautions and upgrades were implemented by TXSTATE; a report was provided by Juan Guerra detailing measures taken (unpublished).
		24	The EAA should be prepared to invest in additional research projects in life history of listed species and sampling techniques that span multiple years, if necessary.		Done	No	Yes	Yes	This research is already funded through the refugia program.	Comal Springs riffle beetle life history study (BIO-WEST, Inc., 2016) began first two years in Applied Research and will continue through Refugia; other life history studies will be undertaken through Refugia as well.
		25	Monitoring effectiveness of M&M measures should not be part of the Applied Research Program, but should instead be incorporated within long-term monitoring programs.		Yes; however, certain exceptions may be warranted for specific projects	No	Yes	Yes		While this may be true for long term monitoring, the Applied Research program may be useful for snapshot monitoring questions and issues (e.g., sediment study).

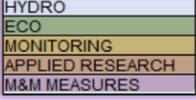
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		26	Resources for ongoing data management activities will need to be allocated throughout the lifetime of the HCP.		No	No	No, but prudent as long as within existing resources and looking for additional funding opportunities	Yes	Currently there is no resources for ongoing database upgrades or maintenance; however, database management activities will continue.	The original database itself was an unfunded initiative agreed to by EAA; staff time can be committed, but building new modules or interfaces does not have funding at this time. Data is available to the public on request.
		27	Modeling efforts should become more integral to consideration of future Applied Research projects; referring to providing data and informing operating, refining, and expanding models.		TBD	No	Yes; with the caveat that the Applied Research budget only extends until 2019	Yes	A public process will be followed for the implementation of both the hydro and eco models, through which any additional research needs may be identified (but are not anticipated).	Modeling has been supported via past Applied Research projects; may be looked at in the event the eco model is updated in the future. There is a placeholder in the 2018-2019 research program in case this would be needed, but is not anticipated.
Methodological Issues Associated with Water Quality Monitoring 	Additional methodological considerations should be taken into account in the WQ monitoring program.	28	If the EAA is to use Clean Rivers Program water quality (WQ) data, it should co-located in sampling space and time.	· Evaluate Clean Rivers Program (CRP) data on a predetermined time series analysis to identify trends that adversely affect the systems; · There is value to the NAS recommendation regarding PAHs in sediment as an impact on life-cycle of beetles and salamanders; · In regards to PAH and other nutrient concentrations in sediment, it is more important to determine source than to identify effect; Consider understanding research and monitoring data before making management decisions; · Determine what information is available regarding PAH movement and bioavailability.	No	No	No	No	1. Any changes to the monitoring programs will be considered in 2018/2019. The WQ and Biomonitoring contracts are up at the end of 2018 and will be rebid and renegotiated for implementation in 2019, creating a natural time to incorporate changes; 2. Additionally, the two monitoring programs were just modified as a result of NAS Report #1. These changes were effective for 2017 and 2018. It would be premature to modify these programs again, before realizing the new and additional data that will be generated, and having the opportunity to evaluate the programs after actual implementation.	HCP is coordinating with CRP to obtain its data. Spring systems ambient conditions are extremely constant, clean, and have rapid turnover. Finally, the HCP has no ability to influence the CRP sampling regime.
		29	All nutrient analyses be performed on the same water sample(s).		Yes	No	TBD	TBD		Feasibility and fiscal responsibility will be evaluated once changes are considered in 2018 and 2019.
		30	Frequency and extent of high concentrations of PAHs should be established by more extensive sampling in areas where elevated levels have been identified..		To be determined if problems are detected.	No	No	Yes		The water quality monitoring work group discussed PAHs; based on local knowledge, they were not included for increased sampling. EAHCP will continue to test at current levels for PAHs in sediment sampling. If any problem is detected, the adaptive management process will be used to address the concerns. Bioavailability is being assessed through tissue sampling. Sources are being addressed by EAA, COSM, and potentially CONB.

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		31	If it is not possible to substantially reduce polycyclic aromatic hydrocarbon (PAH) concentrations through sediment removal and source control, evaluation of bioavailability of the PAHs in the sediment should be considered.		In progress - Fish tissue sampling	No	No	Yes		EAHCP recognizes that PAHs could be bioavailable to salamanders and beetles.
Administrative Considerations Associated with the Monitoring Program	The monitoring program would benefit from some administrative considerations taken into account.	32	The EAA should consider forming a standing working group on monitoring that would meet as needed to provide advice and outside perspective on the EAA's monitoring program.	Value in having a standing work group to evaluate cohesion between monitoring programs and effectiveness of conservation measures.	Done, and to be continued again in the future.	No	Yes	Yes		The 2016 monitoring work groups could be reconvened, if needed.
Integration of Monitoring with Other HCP Programs	Synergies can and should be obtained through integration of monitoring efforts with other aspects of HCP's programming.	33	The eco modeling team should have been represented in the monitoring work groups.	<ul style="list-style-type: none"> · Integrate monitoring programs spatially and temporally: <ul style="list-style-type: none"> o Focus on trend analysis and make data available on website (nutrients specifically); o Focus on non-duplication of efforts in gathering data (internally and externally); • Look into informal collection of information by other (non-monitoring) contractors to bolster monitoring data collection (e.g. dumping charcoal from BBQs) 	Done	No	No	Yes		Representative from eco model team attended bio monitoring work group meetings.
		34	The monitoring program should include the long-term data required to test and inform continuous refinements of the ecological model.		TBD	No	No budget identified at this time	Yes		
		35	The EAA should consider deploying the miniDOT dissolved oxygen (DO) sensors used in the Landa Lake dissolved oxygen study as part of the routine monitoring program.		TBD	No	No	Yes		TBD through CONB DO Mgmt. Plan; will be deployed to collect data for DO Mgmt. Plan; may establish a certain threshold at which deployment occurs. If done, will be through Work Plan, not monitoring program per se.
		36	<i>All M&M measures that are implemented as part of the HCP should be integrated into one conceptually unified monitoring program.</i>		Yes	No	Not at this time; see Implementation Strategy	Yes		Logistics and timing likely present an obstacle to fully realizing this; more work than one contractor can likely do, however, coordination possible.
		37	<i>The performance monitoring of M&M measures should be integrated into the existing water quality and biological monitoring programs.</i>		Yes	No	No	Yes		Have added riparian; considering others in the future.

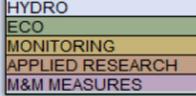
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Submerged Aquatic Vegetation & Related Conservation Measures 	Additional monitoring, effectiveness assessment, and integration should be considered in these Measures.	38	M&M effectiveness monitoring should be done periodically with a comprehensive synthesis of the monitoring data every five years or so.	<ul style="list-style-type: none"> The goal of the non-native vegetation removal and native vegetation restoration is not to strictly increase fountain darter numbers, but rather normalize the eco system and increase health of the system: <ul style="list-style-type: none"> Not dismissing NAS comment, but a broader view of the ecosystem is necessary; Focus specifically on sediment sources prevention rather than removal; Current reevaluation through AMP process was noted and encouraged; To be able to remove enough sediment in the systems is futile. Reducing watershed sources is a better use of funds; Importance in communicating outside organization efforts that complement the HCP efforts (MS4 and SAWS ASR); In regards to the non-native vs. native restoration concern staff should remind NAS that the ITP requires less than or equal to 10% of habitat disturbance in any given year; Landa Lake aeration is ineffective, especially during low dissolved oxygen (DO) as seen in past years; DO management plan is currently in effect; Mini Dot oxygen loggers are a good plan; Should add additional temperature loggers. 	Done	No	Yes	Yes	The EAHCP conducts annual monitoring, with full mapping every 5 years.	This is our plan.
		39	We recommend continuing to compute ratios from data such as those reported in BIO-WEST and Watershed Systems Group (2016), further refining the data to be as species specific as possible.		Yes	No	Yes	Yes	Through CONB and COSM/TXST Work Plans and Annual Report.	Contractors will implement.
		40	In light of October 2015 flooding damage, upstream erosion and stormwater runoff control measures may be needed to protect planting and sediment control efforts downstream.		Yes	No	Yes	Yes	This question will be investigated through the AMP process in 2017.	
		41	There is not enough new habitat from native plantings to maintain populations of fountain darter to balance non-native plant removal.		No	Yes	?	Yes		USFWS has approved the new submerged aquatic vegetation regime and resulting Biological Goals and habitat availability.
		42	Habitat availability for the fountain darter should be verified by considering the carrying capacity of the various submerged aquatic vegetation species (both native and non-native) for fountain darter.		Done	No	No	Yes		Was part of the submerged aquatic vegetation AMP process.
		43	It is important to track the difference between the area of non-native plants removed and the sustained native coverage (reported as m ²).		Yes; in progress continually	No	Yes	Yes	Biological monitoring and submerged aquatic vegetation mapping.	
		44	It is important to track the number of plants planted, resulting sustained area, coverage of vegetation from baseline maps in 2013, and lessons learned regarding new species or techniques.		Yes; in progress continually	No	Yes	Yes	Biological monitoring and submerged aquatic vegetation mapping. Comprehensive mapping to be done in 2018. Also through CONB/COSM/TXST Work Plans.	
		45	Non-native vegetation should be considered as fountain darter habitat when it comes to maintaining and increasing habitat availability for the fountain darter.		Yes and no	No	Yes	Yes	So long as non-native submerged aquatic vegetation exists, it is and will continue to be counted as fountain darter habitat. However, additional non-natives will not be planted to increase available darter habitat.	See also #41; USFWS agrees.
		46	Bank pins and turbidity loggers could be used to evaluate sediment deposition where background knowledge is not currently available. Water depth and sediment accumulation should be monitored in areas being considered for sediment removal as well as post-removal as well.		No - sediment removal is no longer going to be conducted	No	No	Yes	Sediment prevention is being considered and appropriate steps will be taken to ensure a before and after comparison can be conducted.	HCP plans to conduct a before and after study through its 2018-2019 Applied Research program.

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		47	All sediment removal actions should be coupled to monitoring efforts to demonstrate their efficacy.		No - sediment removal is no longer going to be conducted	No	Yes	Yes	Sediment prevention is being considered and appropriate steps will be taken to ensure a before and after comparison can be conducted.	
		48	Sediment removal activities should be limited to areas where ongoing upland sources or natural stream dynamics will NOT lead to deposition of new sediment within a matter of years.		Yes; for this reason, we plan to discontinue removal and move to mitigation/prevention through LID/BMP	No	Yes	Yes	Sediment mitigation/prevention is being considered and appropriate steps will be taken to ensure a before and after comparison can be conducted.	
		49	The Committee recommends that aeration not be used routinely as a mitigation measure, but be held in reserve to be used only in case of severe low oxygen conditions throughout all of Landa Lake.		TBD through CONB DO Mgmt. Plan	No	Yes	Yes	NB is currently conducting research to establish a DO Mgmt. Plan for Landa Lake.	Possible Adaptive Mgmt. action.
		50	Manual breaking up and removal of the floating mats should be considered as a mitigation measure if floating mats cover more than 25 percent of the surface of Landa Lake and dissolved oxygen concentrations decrease.		Yes; through Work Plan; TBD through DO Mgmt. Plan	No	Yes	Yes	NB is currently conducting research to establish a DO Mgmt. Plan for Landa Lake	Possible Adaptive Mgmt. action; manual breaking up and removal may be added through DO Mgmt. Plan currently under development.
Springflow Protection Measures	Additional analysis of the performance and capacity of the ASR system should be conducted; also, a more systematic approach to Phase 2 decisions is warranted.	51	The Committee recommends that Phase 2 of the HCP implement a Decision Support System to replace the triggers for the spring flow protection measures (e.g., VISPO), or possibly when the HCP is reviewed for renewal.	General disagreement in value of NAS recommendation regarding ASR operation & VISPO triggers; ASR/HCP concern is with species, SAWS concern is to maintain supply and fulfill contract.	Yes and no	No	Yes	No		1. DSS could be utilized; 2. Triggers are based on benefit to springflow and socioeconomic factors.
		52	Due diligence should be applied to verify the future long-term reliability of the ASR system given the importance of the ASR performance to the success of the HCP.		No	No	No	No		The HCP benefits from and leverages the ASR drinking water system owned and operated by SAWS. This existing engineered solution helps protect spring flow since it reduces Edwards Aquifer pumping during the most critical droughts, as outlined in a forbearance contract between EAA and SAWS.
		53	The EAA and SAWS should give consideration to whether geochemical reactions between the Edwards Aquifer injected/recharged water and the aquifer permeable matrix may cause adverse water quality issues in the short or long term (especially as the storage volume increases to encounter aquifer matrix not yet exposed to the Edwards Aquifer groundwater).		No	No	No	No		Since the ASR program stores drinking water in a freshwater aquifer many of the water quality concerns cited by NAS are avoided. Since coming online in 2004, after extensive feasibility testing, there have been no well biofouling indications and all water quality parameters meet/exceed safe drinking water standards. The ASR is highly regulated and includes a data intensive program. The ASR program is iteratively expanding knowledge focused on the implementation of the technology on a local level.
		54	The EAA and SAWS should give consideration to whether there are any geochemical reactions between the injected Edwards Aquifer groundwater and native Carrizo Aquifer groundwater that may cause adverse water quality issues in the short or long term.		No	No	No	No		
		55	The EAA and SAWS should give consideration to whether there is any evidence of mineral precipitation in the aquifer or on well materials (e.g., models or projections of porosity declines in the ASR storage zone) that may affect long-term system performance.		No	No	No	No		

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		56	The EAA and SAWS should give consideration to what the long-term trends in ASR well performance are.		No	No	No	No		
		57	The Committee recommends that at a minimum of annually, determine specific injection at each ASR well to assess if there are any long-term changes in ASR well performance.		No	No	No	No		
		58	The Committee recommends to design and implement water quality monitoring for arsenic and related constituents in monitoring wells during recharge and storage events.		No	No	No	No		
		59	The Committee recommends to design and implement water quality monitoring in ASR wells during recovery events.		No	No	No	No		
		60	The Committee recommends that compliance of the parties participating in the spring flow protection measures be audited due to the high expense of the spring flow protection measures and their importance to the HCP's success.		Yes	No	TBD	TBD	TBD; recommended for consideration by the Stakeholder and Implementing Committees	
Modeling for Phase 2 Decisions 	MODFLOW should be used to help develop strategic decisions associated with adaptive management and revisions to minimization and mitigation measures.	61	Developing a more refined framework that incorporates modeling into the decision criteria for triggers rather than relying on triggers based on measured groundwater elevations at specific wells should be considered in planning for Phase 2 of the HCP.	<ul style="list-style-type: none"> Regardless of how the phase II decision is made with respect to MODFLOW output, clarity and transparency should be at a maximum; A regional scale decision support system incorporating MODFLOW predictive output would be useful; Reevaluate the benefits of other springflow protection measures (i.e. RWCP, VISPO) (from Monitoring/Mitigation group); In addition to using model output to predict cessation of spring flows, the empirical record should be examined to determine if there are measurable early warning signs. 		No	Yes	Not in Phase I; however, may be considered in Phase II.	Conduct the Phase II Strategic AMP, recognizing that EAA has model uses beyond the HCP.	1. Triggers are based on benefit to springflow and additional socioeconomic factors outside of the EAHCP purview. They are mandated by statute and cannot be changed.
		62	A decision support system (DSS) should be developed to be used in Phase 2 of the HCP in order to apply the model to short-term decisions (e.g., a one-month time frame) related to determining springflow protection triggers.			No	Yes	Not in Phase I; however, may be considered in Phase II.		1. At the workshop, a DSS utilizing model predictions was discussed with many favorable comments. This may be a valid future tool; 2. However, triggers and mgmt. strategies are annual, not monthly.
		63	A DSS would clearly direct these decisions on the basis of different model outcomes. A good DSS is developed and applied with the understanding that model predictions, although uncertain, represent the best available science on which to base management decisions.		Only to the extent it is part of the Phase II process	No	Yes	Not in Phase I; however, may be considered in Phase II.		1. At the workshop, a DSS utilizing model predictions was discussed with many favorable comments. This may be a valid future tool.

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		64	MODFLOW should be used to evaluate scenarios that help understand what processes are important in the system. Examples would include applying the model for testing concepts, parameters, and system conditions, not just producing predictions, which can be highly uncertain.			No	HCP has no budgeted allocated for this exercise; however, this may be appropriate for the EAA program.	Yes		1. Exploratory modeling is not part of the EAHCP; however, EAA has done this to some extent through model development and will document in Groundwater Model Report. 2. At the conclusion of Phase II, EAA will use the model to continue to assess mgmt. strategies and explore mgmt. options--also, much of this is implicitly captured by modeling a range of hydrologic conditions over the 50+ year calibration timeframe.
Modeling Scenarios	Optimizing the bottom-up package of the four spring flow protection measures (scenario to test hydrologic model).	65	Testing a variety of scenarios will not only improve the confidence in the model itself but also will help develop strategic decisions associated with adaptive management and revisions to minimization and mitigation measures.	A comparison of the old versus new model should be conducted with respect to the bottom up package; • It is important to highlight that during the bottom up package runs we assume maximum permitted pumping. In reality we don't near (?) the maximum permitted pumpage of 572,000 acre feet; In addition to examining the bottom up package we should consider future extreme weather (floods and droughts).	Only to the extent it is part of the Phase II process. This is an EAA effort, not required by the HCP.	No	No	Yes	Conduct the Phase II Strategic AMP.	1. The Hydrologic Model will first be used for the Phase II process (recreating the bottom up package and determining if the minimum springflows described in the HCP are met). If the minimum springflows are not met, then the model will be used to establish which conservation measures could be increased or added to achieve the minimum springflows; 2. Exploratory modeling is not part of the EAHCP; 3. At the conclusion of Phase II, EAA will use the model to continue to assess mgmt. strategies and explore mgmt. options; 4. In 2017 and 2018, the EAHCP is conducting an AMP process for ASR. This process is equivalent to an optimization exercise. 5. EARIP conducted an optimization exercise with HDR. 6. With regards to #67, ASR is being looked at as the optimum strategy and efforts are moving forward to implement a possible adaptive management action.
		66	There is currently no information on any attempt to optimize the combination of measures including the magnitude and spatial implementation of each or the order in which they might be implemented. In such an analysis, the objective function could be formulated to minimize the deviations of the spring flow and water level targets.			No	No	Not in Phase I; however, may be considered in Phase II.		
		67	The Committee recommends that the EAA undertake an optimization analysis of various combinations of the bottom-up package. From this exercise a different combination of measures with different magnitudes may emerge as the optimal combination which minimizes the deviations from the spring flow targets or cost of implementation.			No	No	Not in Phase I; however, may be considered in Phase II.		
		68	An optimization modeling exercise should be conducted using pumping sensitivity analysis results to determine the combination of wells and wellfields that would be most effective in achieving the hydrologic goals of the HCP. A comprehensive analysis of this could provide useful information for developing various options for implementing flow protection measures during future droughts. This scenario can answer the question "Which wells have the greatest influence on index wells or discharges from the springs?"			No	No	Not in Phase I; however, may be considered in Phase II.		
Concept/Scenario Testing	MODFLOW should be used to test a variety of scenarios to improve the confidence in the model itself once current improvements to the model are complete.	69	The groundwater model should be tested against the 2011 to 2015 period. This period, which includes both very dry and wet years, offers a remarkable opportunity to validate the model and enhance confidence in the model for future applications.	Instead of focusing on the drought of record in the 1950s we may consider focusing our efforts on modeling future drought scenarios; • The success of springflow protection measures	In progress / Done	No	Yes	Yes	EAA modeling staff is currently conducting	This is being conducted as a validation exercise. Will be documented in the Groundwater Modeling Report. 2011 was already included in calibration; 2012-2015 has been added.

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		70	Past droughts of shorter duration with more or less intensity are also of interest in understanding the effectiveness of flow protection measures and to test the model's accuracy. Testing how well the model can predict responses during such lesser extremes may demonstrate its applicability to a variety of climatic conditions and further enhance the confidence in the model for adaptive management and for other applications in Phase 2 of the HCP.	provided by the HCP should be documented using the 2011-2014 drought; • We should consider the possibility of future reduced reliance on Edwards water sources. Municipalities are beginning to diversify.	In Progress / Done	No - The EAHCP is required to protect against a repeat of the DOR, Springflow Protection measures are not designed to alleviate the impacts of a more intense 1 or 2 year drought.	Yes	Yes		1. This will be conducted as part of the 2011-2015 validation exercise; 2. The EAHCP is required to protect against a repeat of the DOR, Springflow Protection measures are not designed to alleviate the impacts of a more intense 1 or 2 year drought.
		71	A hydrologic scenario that simulates climatic and socioeconomic conditions more severe than the DOR should be designed to test the model. The DOR may not represent the true worst-case scenario as the baseline for hydrological modeling (Report 1).		No	No - The EAHCP is not required to protect against a drought worse than the DOR.	No	No		1. The EAHCP is only required to protect against a repeat of the DOR; 2. At the conclusion of Phase II, EAA will use the model to continue to assess mgmt. strategies and explore mgmt. options. 3. Existing model uses total pumpage, which is typically much more than actual pumpage. This makes it a highly conservative estimation. 4. "Changed circumstances" clause provides a mechanism to retool. 5. Two studies have been published on tree ring data (Cleaveland, Votteler, Stahle, Casteel, & Banner, 2011; Mauldin, 2003). 6. Given short ITP duration, this is a discussion more relevant to the permit rollover.
		72	The use of paleo data (e.g., tree rings) and possibly stochastic modeling of rainfall patterns should be explored for the development of extreme modeling scenarios.		No	No - The EAHCP is not required to protect against a drought worse than the DOR.	No	Yes		
		73	Climate scenarios should be designed considering the results of climate-model predictions available from regional climate models that are nested within general circulation models.		No	No	No	Yes	Include in discussions for ITP rollover	The EAHCP IC has not made any decisions about climate change. Those decisions will likely be part of the ITP rollover discussions starting in 2024. It is suggested that a white paper should be produced on the HCP's policy position concerning climate change, which could be discussed with input from the IC, SC, and SH Committees.
		74	Spatial variability in rainfall within the Edwards Aquifer region should also be explored in scenario investigations.		Done	No	Not within HCP's scope and budget. However, EAA is conducting significant work with recharge rates in the model, which effectively simulates spatial variability in rainfall.	Yes		Spatial variations in rainfall are accounted for through variations in recharge estimates during the calibration process. Simulations explicitly examining spatial distribution may be useful, but aren't required for Phase II.

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		75	A scenario with projected land use changes and likely change in climate (but no change in water withdrawals by well pumping) over the next two to three decades should be simulated to answer the question "How would a changes in recharge amount due to changing land use impact spring flows?"		No	No	No	Yes	No	This question was examined in a study conducted by The Nature Conservancy (Ryan Smith, unpublished). Uncertainty involved in recharge would drown out land-use inputs. San Antonio has a land protection program over the recharge zone that has protected over 130,000 acres to date.
		76	Use telescoping grids in hydrologic model. Modeling smaller areas can address some of the NAS Report 1 Work Group's concerns about cost and feasibility in testing conceptual models because there is no need to reconceptualize the entire HCP model.		The Work Group acknowledges the integrity of this recommendation, and although it does not fit within the HCP's scope, it may be explored separately (e.g., through Permittees)	No	No	Yes	Will be undertaken by the EAA.	When EAA begins its next iteration of model building in 2019, it will at that time investigate all new and historic modeling platforms as well as examining the conceptual model. The use of telescoping grids will be considered.
Recharge Methods	A recharge estimation ensemble should be created using as many different recharge estimation methods as feasible, and varied uncertain recharge parameters within these methods.	77	The ensemble will provide a range of possible outcomes for spring flows, and this range can be examined for calibration periods, validation periods, and most importantly for future scenarios predicted by the model.	Ways to protect springflow through artificial recharge should be considered.	In progress	No	No	Yes		1. The EAA is currently exploring numerous methods to establish a better recharge estimate (water balance, refined Puente, HSPF, etc.). Presently, the EAA is using an ensemble approach to bracket the range of recharge; 2. It is understood that recharge is an area of uncertainty in the model and therefore needs to be refined as resources allow; 3. DAYMET would not be an appropriate source of precipitation during the WSR-88 NEXRAD record, DAYMET uses interpolation schemes from fixed ground stations, as opposed to the spatially explicit measurements provided by radar. 4. Would require a great deal of investment in staff time and resources, for questionable payoff and (in case of #79) questionable applicability to karst systems.
		78	Daymet data should be considered for recharge estimation instead of NEXRAD. Daymet data contains gridded weather parameters for the United States at a 1-km resolution for 1980 to the present.		No	No	No	No		
		79	USGS' soil-water-balance (SWB) model should be used to enhance the ensemble for estimating recharge. This model estimates spatially distributed daily recharge on the basis of gridded weather and soils data.		No	No	No	No		
EAA Five-year Modeling Plan	The Five-Year plan should provide more details about what updates are going to be incorporated.	80	Providing more specifics about what updates will occur enhances communication.	• Formally document work that has been done		No	Yes	Yes	EAA staff at the direction of the EAA GM will continue modeling efforts that are not required by the HCP; may or may not be implemented.	1. The EAA is committed to continual model upgrades as new information is learned; 2. EAA will update its modeling plan as necessary; 3. EAA will be transparent in communicating all information related to the Hydro Model; 4. The EAA 5-year modeling plan is not an EAHCP requirement. 5. 5-Year Plan does incorporate an iterative approach, and is strategically updated every year. 6. A DSS for making decisions
		81	The Five-Year plan needs to show an iterative approach between data collection and model updates; it does not do so now.			No	Yes	Yes		
					Yes. This is an EAA effort, not					

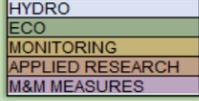
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		82	It may be necessary to update the Five-Year plan more frequently than every five years (e.g., every two to three years) if new information becomes available and the original plan becomes outdated.		an HCP requirement.	No	Yes	Yes		in Phase II will be considered (#83).
		83	A decision support system should be included in the Five-Year plan.			No	No	No		
Interactions between Modeling & Monitoring	There should be a modeling team member who communicates regularly with the monitoring team about how current research can be incorporated into the model.	84	A formal versioning system should be used, consisting of a model archive and peer-reviewed report identified by a unique version number, with a model update occurring about every five years. Once the model moves from the development and calibration stage to operational mode, it should be formally documented as a public record at a high level of transparency.	None.	In progress - EAA is currently conducting a peer review of the model and will produce a report specific to this version of the model.	No	Yes	Yes		1. EAA is currently conducting a peer review of the model and will produce a report specific to this version of the model.
Additional Data	The importance of collecting additional field data to improve the groundwater model was discussed in some detail in Report 1.	85	<i>Data associated with characterizing conduits and evaluating Trinity-Edwards hydraulic connections should be incorporated to improve the groundwater model.</i>	None.	Yes - as data and resources allow.	No	No	Yes	EAA is currently conducting a interformational flow study that will provide data related to the Edwards/Trinity interaction.	1. Will be included to the extent practical in the next major update.
		86	<i>All available pumping data should be incorporated to improve the groundwater model.</i>		Yes - as data and resources allow.	No	Yes	Yes		
		87	<i>Rainfall variation data from the past few years should be high priority for incorporation in the groundwater model.</i>		Yes; in progress	No	Yes	Yes		2012-2015 recharge estimates have been added to the model.
		88	<i>Conduit and barrier features in the MODFLOW model were adjusted based on FEFLOW modeling, but additional evaluation of these features could be considered.</i>		No	No	Yes	Yes		Conduits are not a priority; establishing areas of high transmission and refining other high priority areas of the model will come first. The two models were not based on each other.
Sensitivity Analysis	Use additional calibration and validation metrics.	89	It is essential that the EAA strives to improve the predictive skills of the model for the anticipated refinements to the flow protection measures that may be necessary in Phase 2. The MODFLOW model is expected to continue to be the primary groundwater modeling tool for the HCP.	None.	Yes - in progress.	No	Yes	Yes		
		90	The EAA should conduct a sensitivity analysis involves field tests using a set of wells thought to have the highest sensitivity to water levels at index wells and flows at springs. Pumping at these wells could be increased by some percentage for a certain length of time (e.g., one-two months).		No	No	No	No	No	Could be considered by the EAA in the future; however, a logistical constraint is the fact that pumping must occur at a impracticably huge rate to influence resulting index well or springflow levels.

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		91	Conduct more explicit sensitivity analysis. Technique(s) to quantitatively assess model uncertainty, that should be used and presented in formal EAA documents.		Yes	No	?	Yes		
Uncertainty Analysis	An ensemble approach should be used to analyze sensitivity to help quantify uncertainty.	92	Public misunderstanding about uncertainty analysis should not be used as an excuse to limit best practices in modeling. Moreover, techniques should be applied to improve model design and data collection that decrease uncertainty.	Uncertainty analysis should be considered in the permit rollover and be a guiding principle in the direction of future research; • Where does EAA model output exist on space of uncertainty?	Yes	No	Yes	Yes	The Implementing and Stakeholder Committees need to have a future overarching discussion, with input from the Science Committee, about when/if to use uncertainty analysis and error bars, and for what purpose.	1. Any analysis or work involving uncertainty analysis should and will be transparent and public; 2. The EAHCP Committees need to have a policy discussion around uncertainty analysis; 3. As expressed at the NAS workshop, uncertainty analysis should be used primarily to select and prioritize future research; 4. EAA has conducted uncertainty analysis on the MODFLOW model. It identified recharge as the most significant area of uncertainty. 5. Some dimensions of uncertainty analysis (#93) will be documented in Groundwater Model Report; 6. EAA believes USGS recharge estimates are better (#95) and they are also required to be used by statute; 7. Error bars imply uncertainty is better understood than what it actually is. This will be part of the larger discussion with IC and Stakeholder committees (#97)
		93	One of the 5 methods of uncertainty analysis recommended in Report 1. There was no indication that other conceptual-model parameters, boundary conditions, or other assumptions will be included in an ensemble approach for uncertainty analysis.		Done	No	Yes	Yes		
		94	Recharge estimates from the HSPF method should be included in the ensemble approach being used for uncertainty analysis.		In progress	No	Yes	Yes		
		95	No new progress on HSPF modeling since the first Committee meeting (February 2014) has been presented. The EAA spent considerable time developing recharge estimates using HSPF.		No	No	Yes	Yes		
		96	Using PEST predictive uncertainty analysis. One of the 5 methods of uncertainty analysis recommended in Report 1. The RRWG identified uncertainty analysis in the Five-Year plan, but only the ensemble approach is mentioned.		In progress	No	Yes	Yes		
		97	Show error bars on spring-flow and water-level predictions. One of the 5 methods of uncertainty analysis recommended in Report 1...the Five-Year plan does not mention error bars, and modeling results shown at the committee meeting on February 2, 2016 did not incorporate them.		TBD by Committees	No	Yes	Yes		
		98	FEFLOW stratigraphic data should be incorporated into the current MODFLOW model.		None.	Not within HCP's scope; however, could apply for EAA	No	Yes		

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		99	Lessons learned from incorporating the contributing zone in FEFLOW should be articulated so that they can be used to inform the current MODFLOW model.		Yes	No	Yes	Yes		
		100	Devote future resources to a single model.		EAA has moved to one model	No	Yes	Yes		
Ecological Model Scenario Testing 	There are several different scenarios and/or issues that should be investigated using the ecological model.	101	To explore how submerged aquatic vegetation habitat affects fountain darter, the timing of the existing maps could be switched within simulations to determine whether simulated fountain darter population dynamics are sensitive to sub-regional scale and interannual variability in the observed submerged aquatic vegetation (habitat) record.	<ul style="list-style-type: none"> Low flow and spring flow protection measures should be simulated; Catastrophic simulation would be a useful exercise for refugia planning (e.g., to model reintroduction and population growth); Eco model should look at a range of flows, not just extremes; It would be useful to use a wider lens to apply eco model to a variety of different questions (not just darter populations); The eco model can be used to simulate conditions to approximate different climate change scenarios, and should be used for this purpose—planning for climate change should begin sooner, rather than later, to begin building new data to support the renewal of the ITP; Eco model should be used to verify darter density per submerged aquatic vegetation metrics; High flows, such as flooding, should be simulated; Streambed morphology should be examined with a view to identifying whether velocity shelters would be appropriate to situate in the river channel to provide additional protection to Covered Species, such as the darter; Eco model should be used to identify what environmental factors are most critical for influencing darter populations (e.g. under low flows, are certain parameters most critical to manage for?); Eco model should include impacts of runoff on water quality; The general orientation towards the model should be one of maximizing its usefulness. 	Not in Phase I; however, selected projects may be undertaken in Phase II through a prioritization process, but only to the extent resources allow.	No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	<ol style="list-style-type: none"> The Ecological Model was designed specifically for the Phase II process to ensure that the fountain darter would recover after a repeat of the DOR mitigated by the bottom up package.; Currently, the Ecological Model contract has expired and there are no remaining dedicated resources to do further development on the Ecological Model or run additional scenarios; Exploratory modeling is not part of the EAHCP; However, is possible that modeling could be conducted after Phase II and used to evaluate aspects of Conservation Measures. Any one scenario requires significant time and investment in resources; does not simply entail twirling a dial on the model and hitting "run." Some specific questions might be addressed sooner if resources are available; the Science Committee will be used to vet these.
		102	A scenario could be run to force fountain darter population reductions (simply remove individuals on a day in certain areas) and determine the time period that the population remains below a threshold and the subsequent rate of recovery of the population to a healthier value.		No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.		
		103	Running the model under low flows and for flow protection measures to evaluate the impact on predicted submerged aquatic vegetation is a critical question for the fountain darter model.		No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.		
		104	Pushing the model to catastrophic scenarios – for example where submerged aquatic vegetation is only present in refugia – might reveal some insights regarding recovery following such an event.		No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.		
		105	Examining simulated maps of submerged aquatic vegetation representative of "good" and "bad" years in various virtual time series should be done in a dynamic submerged aquatic vegetation model.		No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.		
		106	A possible useful application of the model would be to better understand the degree of long-term maintenance that might be required to eradicate non-native species.		No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.		
		107	The EAA should explore the diagnostic abilities of this mechanistic model to better understand the environmental forcings that influence vegetation, and to identify future applied research questions that might best serve management goals.		No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.		

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		113	Factors like low dissolved oxygen, sediment removal, algal blooms, gill parasites, and shifts in prey and predator composition can all be examined with the fountain darter model.			No	No	No	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		114	To explore how submerged aquatic vegetation habitat affects fountain darter, observed submerged aquatic vegetation habitat maps could be retained in simulations, but adjust growth, mortality, or reproduction of the fountain darter individuals to reflect when they are in the areas where submerged aquatic vegetation is expected to respond to the management actions.		Done	No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		115	To explore how submerged aquatic vegetation habitat affects fountain darter, existing submerged aquatic vegetation habitat maps could be used, and manipulated to reflect expected changes based on the management actions.		Done	No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		116	A first effort to evaluate the impact of changed coverage by native versus non-native submerged aquatic vegetation species on fountain darter populations could be useful given recent submerged aquatic vegetation AMP.		No	No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		117	The focus on using the fountain darter model to predict the responses of fountain darter abundance to alternative HCP flow control packages is useful, but there are other uses of such mechanistic models that should be considered.		Done	No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		118	The conceptual and predictive ecological models should be used to evaluate the minimization and mitigation (M&M) measures, both in terms of appropriateness and efficacy.		Only to the extent it is part of the Phase II process	No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		119	Scenario analysis should be used as part of a broader iterative process inherent in all ecological modeling.			No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
		120	Scenarios should be defined based on the management needs, to advance our understanding, and to identify critical data gaps.			No	No	Yes	Possible during Phase II. At the conclusion of Phase I (around 2021) all possible runs will be compiled and a public process used to prioritize.	
Definitions, Clarity, and Nomenclature in Ecological Modeling	Definitions of terms, clarity and transparency of model assumptions, and standardized language should be used in the ecological modeling program.	121	All scenario questions should be well defined.	• "Low flows" should be defined; • Uncertainty associated with model predictions must be provided; • The model is not "done" and care must be taken representing it as such (might instead be	Done	No	Yes	Yes		1. Heading items 121-133, extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, & BIO-

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		122	The conditions under which the model was developed should be compared to the conditions for which the model will be used in scenarios, in order to determine the degree to which the model is within in its domain of applicability	described as HCP's "task" being done; the model itself is inherently iterative); • Once uncertainty has been quantified, then you could call the model "done"	Yes	No	Yes	Yes		WEST, Inc. , 2017). 2. A separate uncertainty analysis is not being done and there is no budget for it (#126).	
		123	There should be an explanation of the expected effects of a scenario on and what and how these effects are represented in the model (either explicitly or implicitly).		Done - in model report for scenarios run	No	Yes	Yes			
		124	There should be confirmation that the major effects are represented in a reasonable way for each scenario.		Done in model report	No	Yes	Yes			
		125	Sources of stochasticity represented in each scenario should be identified and acknowledged to account for expected variability.		Staff agree	No	Yes	Yes			
		126	Dimensions of uncertainty in each scenario should be tracked and acknowledged to account for variability.		Yes, but to the extent practical, and as resources allow (however, see strategy)	No	No	No	Currently there is no additional uncertainty analysis planned for the Eco Model.		Currently there is no additional uncertainty analysis planned for the Eco Model.
		127	The baseline conditions and dimensions of the predictions (temporal and spatial scales; absolute or relative terms) should be clearly stated as part of specifying each scenario.		Yes; can be implemented going forward.	No	Yes	Yes	Heading items 121-133, extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, & BIO-WEST, Inc. , 2017).		
		128	Predictions for scenarios should include, at some level, model-based explanations of why the predicted response occurred.		Yes	No	Yes	Yes			
Administrative/Logistical Considerations Associated with the Ecological Model	There are some overarching logistical and/or administrative considerations that must be taken into account to ensure the mode is used appropriately.	129	General information regarding sensitivity analyses that should be used to inform the limits and expectations for model runs should be made available.	Model runs and outcomes need to be communicated to stakeholders and the public; • There should be a public process for vetting the benchmarking of acceptable levels of risk/ uncertainty; • It's important to put into perspective what the decision context is when adjudicating what level(s) of uncertainty is/are acceptable; • Care should be taken in interpreting results around extremes (e.g. low flows);	Done - to the extent that sensitivity analysis was performed, it is in interim and final reports to be issued summer 2017.	No	Yes	Yes		Heading items 121-133, extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, & BIO-WEST, Inc. , 2017).	
		130	A simple one-time transfer of the models from the developers to the EAA should be avoided because this can result in inefficient, and even possibly erroneous, use of the fountain darter and submerged aquatic vegetation models.		Agreed - in progress	No	Yes	Yes			

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		131	The temporal and spatial scales of the submerged aquatic vegetation and fountain darter models are reasonable but the representativeness of selected reaches and the variance properties associated with the use of QUAL2E outputs as model inputs should be clearly documented.	<ul style="list-style-type: none"> We need to meet again to revisit the eco model once it's operational and once uncertainty is quantified, to have a more informed and timely discussion 	Done - in model report	No	Yes	Yes		Heeding items 121-133, extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, & BIO-WEST, Inc. , 2017).
		132	The issues and recommendations described in NAS' interim eco model report should be adequately addressed prior to running the scenarios.		Done to the extent applicable	No	Yes	Yes		The interim report was provided to the Eco Model team to allow for incorporation of appropriate recommendations.
		133	All model results should be carefully labeled according to the nomenclature described in Report 2.		Done	No	Yes	Yes		Heeding items 121-133, extra effort has been made in editorial reviews of the final report to make output understandable and meaningful (see Grant, Swannack, Wang, Hardy, Ward, Doyle, Bonner, & BIO-WEST, Inc. , 2017).
Directions for Further Development of the Ecological Model	The ecological model program would benefit from additional work to refine the model.	134	Sexual and vegetative reproduction should be represented in the dynamic submerged aquatic vegetation model.	Scope creep is inevitable; therefore, it is important to keep an eye on budget and goals; • To expand and build model, it would be appropriate to involve other agencies; • The submerged aquatic vegetation component is critical to the eco model; • We need to draw a line on how far we go in responding to National Academy of Sciences input	Should resources become available for further model development, these recommendations will be utilized at that time.	No	No	No	None at this time.	Currently, the Eco Model contract has expired and there are no remaining dedicated resources to do further work on the Eco Model or run additional scenarios. Additional development may be undertaken in future ITPs. #138: Current sampling meets USFWS metrics. If metrics change, sampling strategies might need to change. Consideration may be given to this if funds are available.
		135	The EAA should continue with the conceptualization of the overall ecosystem by building on the fountain darter and submerged aquatic vegetation conceptual models.			No	No	No	None at this time.	
		136	The current habitat suitability analysis for TWR should be treated as a hypothesis and tested for robustness throughout the San Marcos River.			No	No	No	None at this time.	
		137	The EAA should return to Report 1 for a thorough evaluation and recommendations on their earlier approach and consider new methods that have evolved to address some of the issues with the classical habitat suitability approach if the suitability analyses are pursued in the future.			No	No	No	None at this time.	
		138	A better Comal Springs riffle beetle sampling approach is needed for determining ITP compliance, estimating the current Comal Springs riffle beetle population, and projecting future changes.			No	No	No	Comal Springs riffle beetle module not included in the model at this time.	

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		139	The EAA should be prepared to develop detailed monitoring plans for the other covered species if the Comal Springs riffle beetle is abandoned as an indicator species.			No	No	No	None at this time.	
		140	Explicit treatment of how actions directed at submerged aquatic vegetation would affect fountain darter through the coupled models is recommended.			No	No	No	None at this time.	
		141	The use of an individual-based approach imbedded within a 2-D spatial grid for full life-cycle simulations of fountain darter population dynamics is a scientifically sound framework for the questions being asked, but there remain some important steps (related to how submerged aquatic vegetation) is represented) to link the fountain darter dynamics to their habitat.			No	No	No	None at this time.	
		142	The representation of the processes of fountain darter growth, mortality, reproduction, and movement presently in the model are well-founded but may be too simple and not sufficiently linked to changes in habitat and flow to answer some of the important management questions.			No	No	No	None at this time.	
		143	The submerged aquatic vegetation model is not yet far enough along in its development for detailed suggestions regarding scenarios.			No	No	No	None at this time.	
		144	The historical time period used for calibration had relatively similar environmental conditions from year-to-year, which limits the range of conditions of scenarios feasible for exploration by the model.			No	No	No	None at this time.	
		145	The representation of flow effects in the model seems too limited in potential effects due to reliance on having site-specific empirical evidence for the effects.			No	No	No	None at this time.	
		146	Thresholds in process representations should be used cautiously because they can erroneously create nonlinear population responses and unrealistic sensitivities to changes in habitat & flow.			No	No	No	None at this time.	
		147	The representation of density-dependence and how its effects on individuals manifest at the population level needs further evaluation.			No	No	No	None at this time.	

Report 2 Implementation Matrix

Category	Synopsis	#	Recommendation	Workshop Input	Implementation Recommended	Compliance-oriented	Fiscally-feasible	Feasible	Implementation Strategy	Comments
		148	Calibration and validation of the fountain darter model to date shows the model can reproduce the historical abundances, but additional confidence is needed to most effectively use the model for management purposes.			No	No	No	None at this time.	
		149	<i>As a top priority the EAA should develop an ecosystem-based conceptual model, or a series of conceptual models of increasing resolution, that show how water quality and quantity, other biota, and restoration and mitigation activities are expected to interact with the indicator species, as well as with all covered species.</i>			No	No	No	None at this time.	
		150	<i>The habitat suitability analyses done for the fountain darter should be used as a "back-up" to the individual-based modeling and provide additional quasi-independent results to support a weight-of-evidence approach for the fountain darter.</i>			No	No	No	None at this time.	
		151	<i>A much deeper understanding of the Comal Springs riffle beetle's natural history should be obtained in order to be able to include the Comal Springs riffle beetle in a mechanistic model.</i>			No	No	No	None at this time.	