WAM Technical Issues 2015

The WAM Resolved Technical Issues document was originally prepared to provide a means for memorializing decisions regarding how water rights and related issues were addressed during the initial development of the Water Availability Models (WAMs) for each basin in the State of Texas. This document includes updates to the WAM Resolved Technical Issues as of 2015.

Development of the WAM datasets was completed in 2003; however, the Texas Commission on Environmental Quality (TCEQ)[1] has continued to fund development efforts for the Water Rights Analysis Package (WRAP) simulation programs. Some issues in the original document were only relevant during the initial model development process and now are obsolete. Those obsolete issues have now been included in Appendix A. Other issues have been superseded by more advanced modeling techniques or have been modified as TCEQ uses the models to process water rights permit applications. This document is not intended to provide detailed discussion of modeling procedures or methods. Much of this information is included in existing WAM documentation and WRAP Technical Reports. Final WAM reports are available online at http://repositories.tdl.org/twdl-ir/handle/10850/1309. A summary of changes to the WRAP code over time can be found in the Additions and Revisions Report located at http://ceprofs.civil.tamu.edu/rwurbs/wrap.htm. This website also contains the most updated User and Reference Manuals and the most current version of the WRAP model.

1. Iterative Solution Assumption (12/1/2015)[2]

Discussion:

During the first WAM Technical Meeting on August 3, 1998, instream flow and bay and estuary flow requirements were discussed in relation to the Water Rights Analysis Package (WRAP) model modifications. The suggestion was put forth to employ a simplifying assumption in the modifications to WRAP that ignores all junior releases that happen later in the WRAP computational loop. This assumption would prevent the necessity of implementing an iterative solution into the WRAP code. Two options were considered: (1) Adopt the simplifying assumption described above to prevent WRAP from requiring an iterative solution, which means that any water subsequently released by a junior right will not necessarily be counted toward an instream flow requirement for a downstream senior right; or (2) Recode WRAP to provide for an iterative solution, which would be labor and time intensive, because WRAP processes water rights in priority order.

Risks:

Adopting the simplifying assumption was considered a small compromise to the accuracy of WRAP. This risk was counterbalanced by the larger risk associated with project delays if WRAP was recoded to allow for an iterative solution. The use of an iterative solution would have delayed established timelines for delivery of WRAP for

[1] TCEQ, as used throughout this document refers to the TCEQ and its predecessor agencies
[2] Date when the technical issue was last updated

development of the WAM for the first basin. Depending on the actual time it would take to recode WRAP, this reprogramming could have resulted in the TCEQ not meeting the legislatively mandated deadlines of developing water availability models for six river basins by December 1999.

Benefits:

Use of the simplifying assumption was considered to have substantially lessened the complexity and associated costs of the WRAP code and would have only affected senior water rights with instream flow restrictions. In addition, it would have only affected these senior rights under conditions where an upstream release is made for a junior permit.

Decision:

It was decided that the simplifying assumption would be used in the modifications to WRAP, which ignores all junior releases occurring later in the WRAP computational loop, thereby nullifying the need for an iterative solution in the WRAP code. The WAM Management Team conditionally approved use of the simplifying assumption with the stipulation that consideration be given to modifications to allow WRAP to iterate and account for junior releases in some future version of the model.

Update - 2015

As noted, the original version of WRAP only included the simplifying assumption. Additional functionality was added to WRAP in 1999, August 2003, and January 2009. User specified options allow senior water rights to have access to water made available by junior water rights from return flows or hydropower releases, allow reservoir releases to be excluded from meeting instream flow targets (Hale Clause), allow the user to enable options for specific water rights or for an entire basin, and allow the user to record regulated and available streamflows for both a first and second pass through the water rights simulation loop.

2. Streamflow Restrictions Associated with Permits (12/1/2015)

Discussion:

Streamflow restrictions are special conditions included in water rights permits to help protect downstream senior water rights and/or sustain viable aquatic communities. This issue deals with the implementation of streamflow restrictions associated with permits. The origin of this issue was the question of whether or not streamflow restrictions associated with a permit are special conditions of the permit and, therefore, retain the same priority date as the permit with which they are associated. The options considered were: (1) to require that streamflow restrictions associated with permits be included in the WAM datasets with the same priority date as the permit; or (2) not to require the inclusion of streamflow restrictions associated with permits in the WAM datasets.

Risks:

During the course of discussion regarding this issue, the determination was made that streamflow restrictions associated with permits do retain the priority date of the permit

with which they are associated. In this context, not requiring the inclusion of streamflow restrictions associated with permits in the WAM datasets would be inconsistent with TCEQ policy and the prior appropriation doctrine upon which it is based.

Benefits:

Requiring streamflow restrictions associated with permits to be included in the WAM datasets with the same priority as the associated permit was considered to be consistent with TCEQ policy and the prior appropriation doctrine.

Decision:

It was determined that streamflow restrictions associated with permits would be applied to a water right at the priority date of the water right or amendment so that the streamflow restriction would be satisfied before allowing diversions and impoundment. Additionally, it was decided that diversions and impoundments may be shorted by the amount of streamflow required to meet the streamflow restriction. In essence, a streamflow restriction can be thought of as possessing a priority immediately senior to the water right with which it is associated. Modifications to the WRAP model were incorporated to ensure that streamflow restrictions are processed in accordance with the prior appropriation doctrine.

Update – 2015

Functionality to model streamflow restrictions associated with new water rights or amendments were included in WRAP in 1999 and no further modifications have been made.

3. Conservation Storage Protection (12/1/2015)

Discussion:

During the initial WAM Technical Meetings, there was discussion of when a junior water right would need to pass inflow or streamflow to fill storage in a downstream senior reservoir. The discussion centered on the question of the legal definition; i.e., does a strict definition of the prior appropriation doctrine require a junior right to pass all streamflow until a downstream senior reservoir is full?[3] Historically, this issue has been addressed in various ways, including allowing diversions after the reservoir is less than full (80%, 50%). The options considered were: (1) to allow junior upstream diversions and impoundment to take place after the senior reservoir is less than full; or (2) to require the senior reservoir's permit be fully satisfied before any allocation of streamflow to a junior permit could be met.

Risks:

The risk embodies what is perhaps the letter of the law conflicting with reality. During normal operations, a junior right may be allowed to divert or impound before a downstream senior reservoir is completely refilled. However, as a matter of policy, an application for a water right before the TCEQ must be evaluated in accordance with the

[3] In this context, an off-channel reservoir is not considered a downstream senior reservoir.

letter of the law. Additionally, this decision affects the amount and timing of available water reported by the model.

Benefits:

The benefit of requiring that a senior reservoir's permit be fully satisfied before any allocation of streamflow to a junior permit is that the estimates of available water will then be consistent with how the TCEQ would estimate available unappropriated water in a permitting setting. The benefit of allowing diversions after the reservoir is less than full is that it may more closely mimic how reservoirs are physically operated and could provide more realistic estimates of available water in certain cases.

Decision:

As specified in the Texas Water Code, a water right entitles the holder to impound, divert and/or use State water. The priority of a water right is based on the priority date in the permit or certificate of adjudication, and as between appropriators, the first in time is the first in right. In addition, all water rights are granted with express language, stating that such rights are granted subject to all senior and superior rights. It was decided that the accounting of all available water in the new water availability models should be handled in strict accordance with the statutory requirement of first in time is first in right, both for diversions and/or storage of water. Such accounting would assure that the basic elements of determining how much water is really available would be consistent with the Texas Water Code. It was determined that the models should be developed with the flexibility to evaluate the amount of water available if something less than a strict priority basis is used. Such cases would allow a planning region to evaluate various water supply options such as allowing an upstream or downstream diverter, or reservoir owner, the opportunity, through marketing, to purchase rights for either the upstream capture or passage of water downstream. The WAM Management Team recommended that a strict interpretation of the prior appropriation doctrine be followed for all WAM modeling, which requires that a senior water right be fully satisfied before a junior water right can divert or impound water. In addition, the WAM Management Team also recommended that the option of allowing junior diversions upstream at a variable percentage of full for individual reservoirs be added to WRAP.

Update – 2015

For permitting purposes, in accordance with the prior appropriation doctrine, all Full Authorization simulation versions of the TCEQ WAMs include all reservoirs at their fully authorized storage amounts and senior reservoirs are required to be 100% full before junior priority water rights can divert or impound water. TCEQ's Current Conditions simulation versions include all major reservoirs using the most updated available reservoir capacity information. The WRAP program includes functionality allowing the user to specify a lesser standard. A lesser standard for senior priority reservoir storage may be employed under certain circumstances agreed to by the water rights holders, and would be included in TCEQ's permitting models, provided any agreements to a lesser standard are included in the respective water rights.

4. Salt Water Diversions (12/1/2015)

Discussion:

This issue concerns whether or not to include salt water diversions in the WAMs. The TCEQ has issued water rights authorizing diversion and use of approximately 8 million acre-feet of water that is considered "saline" and these water rights can be found in the agency's records. (One example is a right to divert 4.2 million acre-feet of water from the Freeport Ship Channel that is held by Dow Chemical).

Risks:

The WAM is strictly a river system model, and it is assumed for purposes of water availability that assumes that all diversions and impoundments are comprised solely of freshwater streamflows that are available for appropriation. Saline water rights are not dependent upon the availability of freshwater streamflows since they were permitted based on saline water in coastal bays, estuaries, and the tidal portions of streams and rivers. Including salt water diversions in the WAMs would imply that these diversions require a volume of freshwater to be appropriated from streamflow and would result in incorrect freshwater availability estimates.

Benefits:

None

Decision:

Since saline water diversions are dependent upon a supply of saline water from coastal bays, estuaries, and the tidal portion of streams and rivers, it was decided that incorporating them in the WAMs would incorrectly bias model results for freshwater water rights. Saline rights were not modeled in the WAMs. It was decided that they may be included in the models so the input data would reflect all of the existing water rights, but they would have to be incorporated in a manner that prevents them from diverting available fresh water.

5. Area/Capacity Curves (12/1/2015)

Discussion:

The WRAP program requires information that describes the relationship between both the surface area and volume of a reservoir as they vary with water surface elevation. These "area/capacity curves" are used in the calculations of evaporative loss and in the flow balance calculations. These curves are principally a function of the physical dimensions of the reservoir. However, due to sedimentation as a reservoir ages, these relationships change over time. The question that arose during the Technical Coordination Meetings was whether to use the original area/capacity curves developed when the reservoir was constructed (generally referred to as "as built") or to develop predicted area/capacity curves adjusted to some future time. The issue of adjusting reservoir sedimentation to the year 2030 arose to assist the Regional Planning Groups in their analysis.

Risks:

Using projected sedimentation conditions (year 2030) in the WAMs would not provide estimates of the amount of permitted water legally available under a water right and likely would result in misleading results. Using area/capacity curves adjusted for sedimentation to the year 2030 would lessen the reservoir volume and allow junior water rights to access water available to a more senior reservoir under the senior permit holder's water right authorization.

Benefits:

Adjusting reservoir sedimentation to that predicted for the year 2030 is consistent with planning analyses. For planning, and the accompanying analysis of "need", estimates of demands and available water are projected into the future.

Decision:

It was decided that area/capacity curves that reflect the permitted volume (generally using the "as built" area/capacity information) would be used in the WAM Full Authorization simulation, along with full paper water rights and strict application of the prior appropriation doctrine. In the WAM Current Conditions simulation, it was decided that the area/capacity curves would be modified to reflect estimated year 2000 sedimentation conditions and that these area/capacity curves would be updated as new reservoir surveys may be completed in the future.

6. Net Evaporation (12/1/2015)

Discussion:

There appear to be two different quantities being defined as "net evaporation" in the hydrologic industry. TCEQ defines the two separate quantities as: (1) net evaporation and (2) adjusted net evaporation. Both quantities are based on gross evaporation, which is calculated by multiplying observed pan evaporation by the appropriate pan coefficients. Net evaporation is derived by subtracting the observed precipitation from the gross evaporation, while adjusted net evaporation is derived by subtracting the effective precipitation from gross evaporation.[4] The reason for this clarification is that both of these net evaporation quantities can be utilized in the calculation of naturalized flows and in the WAMs for simulating reservoirs. The appropriate evaporation quantity to use in simulating evaporation losses associated with a reservoir depends upon how inflows to the reservoir from its drainage area were developed. Net evaporation is adjusted for precipitation, which was observed (ideally) at the same location where the pan evaporation data were observed. Thus, the reservoir area the net evaporation rate is applied to is already adjusted for all of the inflow, which occurred as 100% of the precipitation that fell on the reservoir. In most cases, inflows to a reservoir are estimated by prorating flow from a similar drainage area to the drainage area of the

[4] Effective precipitation is defined as the quantity of precipitation which does not contribute to surface water flows in a subject watershed because of natural depletions (infiltration, consumptive use, interception, etc.). Effective precipitation is usually calculated by reducing observed precipitation by an estimate of precipitation that is expected to runoff and contribute to streamflow based on rainfall/runoff relationships in the subject watershed.

reservoir. In this case, the outflow of the subject drainage area is usually the site of the dam; thus, the entire drainage area (including the inundated area) is counted as being the contributing area of inflows. After the reservoir begins impounding water, its area occupies a portion of the reservoir's drainage area. Because inflow to the reservoir is based upon the total drainage area of the reservoir's watershed in each time step of a simulation (watershed drainage areas are not usually reduced by reservoir area) there will be some degree of misrepresentation of reservoir inflow and reservoir evaporation if net evaporation is used as the evaporation rate for the reservoir area. This is because reservoir inflows are prorated to include an area for which an adjustment has already been made.

Solutions:

It was determined that there are two valid solutions to this problem:

- Solution 1: Make a correction (adjustment) to the net evaporation rate for the amount of precipitation that would have been lost had the reservoir area not occupied part of the watershed area (adjusted net evaporation); or,
- Solution 2: Reduce the prorated watershed's drainage area by the area of the reservoir for each time step of the simulation.

Risks:

Evaporation data made available to the public (pre-1996) by the Texas Water Development Board (TWDB) represented adjusted net evaporation and is no longer supported by the TWDB. These data were based upon a single set of pan evaporation coefficients for the entire state, as well as a single rainfall/runoff curve for the entire state.

Historically, the hydrological development of reservoir inflows using proration from a similar watershed has employed Solution 1. It is important to note that the use of adjusted net evaporation rates in lieu of net evaporation rates should not be used in the following cases:

- To estimate evaporation losses where the inflow development technique is some methodology other than proration (deduced inflows based on historical change in storage, etc.).
- To estimate actual evaporation losses occurring from an exposed area of water.
- To simulate evaporation losses during the operation of off-channel reservoirs.

Decision:

The TWDB expanded its database of pan coefficients, and developed an improved inventory of appropriate pan coefficients for different parts of the state. Additionally, the TWDB developed historical monthly gross evaporation and precipitation data, interpolated to the center of each 1-degree quadrangle across the state. These expanded resources allowed for a much better representation of evaporation effects in both the development of naturalized flows and WRAP simulations.

Wherever necessary, the WAM contractors were directed to adhere to the terms "net evaporation" and "adjusted net evaporation" to distinguish the two data types in all

model documentation. In the development of adjusted net evaporation rates, the contractors were to utilize the most appropriate precipitation and streamflow gages available for each major reservoir and were to document all data/correlations/assumptions associated with selection of such data. If possible, the WAM contractors were advised not to use pre-1996 TWDB "net evaporation" data in the development of naturalized flows or in the WAM datasets. Instead, they were to develop their own specific net evaporation and adjusted net evaporation data utilizing the most appropriate pan evaporation coefficients available, as well as site specific rainfall/runoff relationships. If existing naturalized flow data from past studies were to be used that were based on pre-1996 TWDB net evaporation data, the WAM contractors were directed to include some analysis of the difference the use of such data may introduce into the final model output. In the November 1998 version of WRAP a new option was added to allow use of Solution 2 as described above.

7. Off-channel Reservoirs (12/1/2015)

Discussion:

Early in the development of WAMs for the initial basins, it became evident that it was difficult to accurately portray off-channel reservoirs in the models. While it is possible to simulate off-channel storage with the WRAP program, the modeling options, as they existed, imposed some problematic limitations. The options considered were : (1) not simulate off-channel reservoirs, but rather treat these water rights as direct diversions; (2) to simulate these water rights with the current limitations in WRAP; or (3) to modify WRAP to more accurately reflect the operation and permit constraints of off-channel reservoirs.

Risks:

There are a number of currently permitted off-channel reservoirs in the state that could increase a water right's reliability. If these off-channel reservoirs are not accurately simulated, it could be difficult to derive accurate estimates of water availability for some water rights.

Benefits:

Off-channel storage increases a water right's reliability by enabling a water right to divert and store water during high flow conditions for subsequent diversion during times when streamflow conditions prohibit diversions. Representing this capability in the WAMs was considered important for obtaining more accurate estimates of water availability for some of these types of projects.

Decision:

It was decided that every effort should be made to simulate water rights that include off-channel storage as having a demand distribution (based on type of use and location within a basin) for diversions from the off-channel reservoir, with the "diversions" from the associated water course limited only by the parameters contained in the water right (diversion rate extrapolated to a monthly quantity, total annual amount authorized, instream flow restriction, etc.). The WAMs were constructed to facilitate simulation of these types of water rights.

Update – 2015

WRAP was modified in August of 1999 to include functionality to model off-channel storage.

8. Minimum Threshold for Reservoir Modeling (12/1/2015)

Discussion:

There are nearly 7,000 reservoirs throughout the State of Texas. Certain small reservoirs are exempt from permitting requirements and are not included in the WAMs; however, all permitted reservoirs are included. The issue here related to the designation of a minimum storage threshold for determining which reservoirs should be included in the naturalized flow calculations. Typically, the effect of all reservoirs need not/cannot be adjusted for in the flow naturalization process. This is because of the large total number of reservoirs in a basin, and the relative size of the large number of small reservoirs verses large reservoirs. For instance, most basins have many, in some cases hundreds, of small reservoirs constructed on non-navigable streams for domestic and livestock use which are exempt from permitting requirements. There is little to no compiled historical information available relating to storage volume or date of construction for these small domestic and livestock reservoirs.

Risks:

The actual development of the WAMs for each of the 23 river basins was to be performed largely by contractors. Without a decision on this issue, the WAMs could be inconsistent across the state.

Benefits:

A consistent methodology based upon coherent assumptions would provide consistent results across the state, meeting the requirements of S.B.1.

Decision: It was determined that all major reservoirs with storage capacities greater than 5,000 acre-feet should be accounted for in the development of naturalized flows for Texas' river basins. Unpermitted domestic and livestock reservoirs need not be explicitly accounted for in the development of naturalized flows or WAMs.

9. Unique Numbering System for Water Rights (12/1/2015)

Discussion:

During WAM development, TCEQ determined that there was no water right numbering system that produced a unique identification number for each water right. In an effort to correct this problem, TCEQ created a numbering system to provide unique identification numbers that contain intrinsic information relative to the associated right.

While the WAMs may be created with any unique identifier for water rights, utilizing the same unique identifier that is to be used in the Geographical Information System (GIS) for water rights would facilitate linkages between the WAMs and the GIS.

Risks:

None.

Benefits:

Utilizing a common numbering system for water rights in the WAMs and in the GIS would facilitate linkages between the two systems and the maintenance of the models in the future.

Update - 2015:

The numbering system has evolved over time; however the current system used by TCEQ is:

The numbering system is TBBWWWWWDDD, where:

T = Type (6-adjudication or 1-permit)

BB = Basin number (01 through 23)

WWWWW = Water right number (adjudication number or permit number

DDD = Descriptor:

001-099 = Direct streamflow or reservoir diversion point

101-199 = Downstream boundary of a diversion area (segment)

201-299 = Upstream boundary of a diversion area (segment)

301-399 = On-channel reservoir

401-499 = Off-channel reservoir

501-599 = Discharge point (such as WWTP discharges)

601-699 = Off-channel diversion point

701-799 = Release point. Water is only available to water right holder (releases from storage for downstream diversion, moving water to other reservoirs, interbasin transfer, etc.)

801-809 = Upstream limit of the discharge area (segment)

901-999 = Other, such as the upstream dam creating one reservoir

10. Return Flows (12/1/2015)

Discussion:

Return flows play an important and different role in both phases of creating a WAM for a river basin: (1) in the development of naturalized flows; and (2) in the construction of the WAM datasets.

Naturalized Flows:

Return flows from various sources must be considered in the flow naturalization process. Many return flows, generally wastewater treatment plant discharges, are a function of surface water diversion. However, this relationship is complicated by the appearance of stormwater infiltration and inflow in the wet weather outfall flows. In addition, in many places, all or part of the potable water supply that eventually becomes wastewater return flows is from groundwater sources.

WAM Datasets:

The Constant Inflow (CI) record can be used to represent simulated return flows in the WAM because, generally, the return flows included in the WAMs are thought to be relatively constant. This is because:

(1) Some entities (mostly municipal and industrial) would likely acquire water from some other source in the event of a drought in which they depleted their surface water supply.

(2) Some entities (mostly municipal and industrial) conjunctively use groundwater and surface water and discharge same; thus, groundwater based return flows would occur even if the surface water component was depleted.

Risks:

There are several options for including return flows in the WAM. Each option has characteristics that could make it more applicable to one type of return flow or another. An inconsistent choice of options could result in inconsistent results across the state. In addition, return flows are included in the WAM Current Conditions simulation and there are time considerations involved in updating these return flows.

Benefits:

A consistent methodology based upon coherent assumptions will provide consistency across the state.

Decision:

Naturalized Flows:

Historical Return Flow is the term that should be associated with return flows used in calculating naturalized flows. Historical return flows should be based on an analysis of actual return flows and thus should consider all historical return flows to the extent practicable. This would include return flows from all types of water use activities regardless of type of use or the origin of the water. For historical return flows that are known to have occurred, but have missing data, the WAM contractor should develop and document a procedure to estimate or fill in the missing periods. Such procedure should be based on accepted hydrologic and engineering principles considering such factors as population, irrigated acreage, crop type, irrigation practice, or similar.

WAM Datasets:

In general, all return flows with a permitted flow of 1 million gallons per day (MGD) or greater should be included in the WAM Current Conditions simulations. Generally, irrigation return flows should not be included in most WAMs; however, these return flows should be included in the WAM Current Conditions simulations for the Lavaca and Colorado River Basins. Return flows in the WAM Current Conditions simulations are represented using CI records. Furthermore, all wastewater discharge permits that are authorized to discharge an average of 1 MGD or greater should be located in the WAMs as control points, although some smaller return flows may be included in the San Jacinto WAM because of basin specific characteristics.

Discharge values on the CI records should be based on the return flow occurrence during the most recent five year period. The CI record generally should include the minimum monthly value for each month of the five year period. TCEQ updates these return flows as needed.

11. Streamflow Restrictions Associated with Downstream Water Rights (12/1/2015)

Discussion:

Streamflow restrictions on diversions and impoundments for the protection of downstream water rights are implemented similarly to other types of streamflow restrictions. The purpose of these types of restrictions in water rights is to protect downstream senior and superior rights from upstream junior water rights diverting or impounding streamflows at the same time. The WRAP program operates in priority order, with streamflows made available to senior water rights before more junior water rights.

If these types of restrictions are included in the WAM, on-the-ground water availability for water rights with these types of special conditions could be misrepresented. Water availability could either be over- or under-estimated. WRAP operates in priority order; therefore, senior water rights would have already had the chance to take the water that was available to them before the junior water right was processed. Adding an additional restriction to those junior rights could result in double-counting the amount of water those water rights would need to pass downstream to senior water rights and water availability for these junior rights would be unduly limited. Conversely, there could be situations, especially for larger water rights, where diversions would be more limited than indicated in the model output.

Decision:

It was decided that streamflow restrictions designated for the protection of downstream water rights generally should not be included in the WAMs, especially for smaller permits. Some restrictions of this type, such as “Hale Clause” restrictions, should continue to be included.

Appendix A
Obsolete Technical Issues

2. Instream Reservations Not Associated with Permits (1/1/99)

Discussion:

The term "instream reservations" in this context refers to instream environmental flow needs to sustain viable aquatic communities. In some cases, instream reservations are requirements included in a permit. However, this issue deals with the implementation of instream reservations that are not associated with permits, such as the Planning Criteria of the Consensus State Water Plan. The two options considered were to model these instream reservations as "rights" that must be met in accordance with a priority date, or to include them as "observation points" that indicate the frequency with which flow targets are met.

Risks:

The principle risk associated with this issue stems from potential controversy related to the priority of environmental flows. Modeling these environmental needs as a "right" would require the contractors, or someone else, to assign priority dates. Such assignment of priority dates would require more policy guidance regarding the priority of documented instream flow demands relative to existing permitted water rights.

Benefits:

Including these instream reservations in the WRAP modeling performed for the WAM as observation points, while providing the flexibility in the WRAP code, mitigates the risk to some extent.

Decision:

Instream flow reservations for environmental needs (both instream and bay and estuary) not associated with permits will be included in the WAM models as "observation points" only. The model control points at which these needs are placed would serve only to report the frequency and extent to which these flow needs were met and not effect any diversions. Others using these models may wish to re-run the model with these types of needs and be able to appropriate water according to a specified priority. The WRAP model will, therefore, include the flexibility to handle these types of flow needs either as "rights" with an associated priority date where they will affect diversions from rights with junior dates, or as "observation points only".

8. Normal Year Calculation (7/1/99)

(See Replacing Issue Titled: Drought Year Calculation)

Discussion:

To meet S.B.1 requirements the WAM models must identify the water available for diversion in the "normal" year, the "75% normal" year and the "50% normal" year.[1] The initial methodology proposed for identifying the normal year tends to select years that are drier than could be considered normal and requires some refinement. A number of ideas were discussed at various WAM Management meetings and at Technical Coordination Meetings. The original methodology specified defining the normal year is

[1] Legislature no longer requires water availability information for 75% and 50% of normal.

based upon the annual available flow at a diversion location. Intuitively, one would expect that the normal year would provide more water for diversion that the 75% normal year, and that the 75% normal year would provide more water for diversion than the 50% normal year. However, all methods investigated based upon annual available flow, at times, failed in this respect. The relationship between available water totaled on an annual basis and, the total annual diversion, is both complex and indirect.

Risks:

None

Benefits:

Provides a year that meets the S.B.1 requirements of a "normal" year.

Decision:

The definition of the "drought of record" that was initially proposed is the year in the record during which the least amount of water can be diverted. The new method would also base the normal, 50% normal, and 75% Normal year upon the annual volume of diverted water. The definitions for "run- of-the-river" permits are:

Drought of Record: For each water right with a run-of-the-river permit, select the single year during which the least amount of water is diverted.

Normal Year: For each water right with a run-of-the-river permit, select the single year that represents the median or 50th percentile year in the simulated annual diversion record.

50% Normal Year: For each water right with a run-of-the-river permit, select the single year that is closest to mid-way between the drought of record and the Normal Year (25% percentile) in the simulated annual diversion record.

75% Normal Year: For each water right with a run-of-the-river permit select the single year that is closest to mid-way between the 50% Normal Year and the Normal Year (37.5% percentile) in the simulated annual diversion record.

The definitions for permits with associated reservoir storage are:

Drought of Record: For each water right with a run-of-the-river permit select the single year during which the least amount of water is diverted.

Normal Year: For each water right with a run-of-the-river permit select the single year that represents the median or 50th percentile year in the simulated annual diversion record.

50% Normal Year:[2] For each water right with a run-of-the-river permit select the single year that is closest to mid-way between the drought of record and the Normal Year (25% percentile) in the simulated annual diversion record.

75% Normal Year: For each water right with a run-of-the-river permit select the single year that is closest to mid-way between the 50% Normal Year and the Normal Year (37.5% percentile) in the simulated annual diversion record.

[2] The 50% and 75% drought information was eliminated by the Texas Legislature.

The definitions are slightly different for permits with associated reservoir storage that do not include an authorized diversion amount. Normally, permits with reservoir storage and no authorized diversion right make up evaporation losses in reservoirs, usually for recreational or industrial uses. For these types of permits the definitions are:

Drought of Record: For each water right with associated reservoir storage and no diversion authorization, select the single year with the lowest mean annual reservoir storage volume.

Normal Year: For each water right with an associated reservoir storage and no diversion authorization, select the single year that represents the median or 50th percentile year in the simulated mean annual reservoir storage volume record.

50% Normal Year: For each water right with an associated reservoir storage and no diversion authorization, select the single year that is closest to mid-way between the drought of record and the Normal Year (25% percentile) in the simulated mean annual reservoir storage volume record.

75% Normal Year: For each water right with an associated reservoir storage and no diversion authorization, select the single year that is closest to mid-way between the 50% Normal Year and the Normal Year (37.5% percentile) in the simulated mean annual reservoir storage volume record.

10. Model Runs (10/22/99)

Discussion:

The WAM analysis is being undertaken pursuant to the requirements of S.B.1, which directs the TNRCC to develop specific information in several areas, including

1. For all existing permits, certified filings, and certificates of adjudication, determine the projected amount of water that would be available during the drought of record, when flows are normal, 75% of normal, and 50% of normal (Note the 76th Legislature's passage of SB 657 removed the 75% of normal and 50% of normal requirements.).

2. Project the amount of water that would be made available if cancellation procedures were instigated as described in Subchapter E, Chapter 11 of the Texas Water Code.

3. Investigate the potential impact of municipal and industrial effluent reuse on existing water rights, instream uses, and freshwater inflows to bays and estuaries.

Accomplishing these tasks and satisfying the requirements of S.B.1 will require several different runs of the water availability model under varying conditions and assumptions. To assure that these needs are met and to provide a consistent set of requirements for each of the model development contracts, the TNRCC must stipulate the specific model runs to be made and the conditions and assumptions that comprise each.

Risks:

The actual development of the models for each of the 22 river basins included in the WAM will be performed largely by engineering contractors. Were the TNRCC to leave the decision of how to meet the S.B.1 requirements to the individual contractors, the results would be inconsistent across the state.

Benefits:

These sets of model runs, along with their associated conditions and assumptions, will provide the WAM project with a consistent set of results across the State that meet the requirements of S.B.1.

Decision:

Each contractor will develop a total of nine runs of the model.[3] All of these runs will require the specific chart output identified earlier in this document. The proposed runs are detailed as follows:[4]

RE-USE RUNS (varied return flow amounts)

RUN 1 (0% re-use)
Authorized diversion amounts
Authorized area capacity parameters
Assumed return flows[5]
No term water rights

RUN 2 (50% re-use)
Authorized diversion amounts
Authorized area capacity parameters
50% of assumed return flows
No term water rights

RUN 3 (100% re-use)
Authorized diversion amounts
Authorized area capacity parameters
No assumed return flows
No term water rights

CANCELLATION RUNS (varied diversion amounts, varied return flows assumptions)

RUN 4 - Modified diversion amounts (10 years of non-use = 0)
Authorized area capacity parameters
Assumed return flows
No term water rights

RUN 5 - Modified diversion amounts (max use for last 10 years)
Authorized area capacity parameters
Assumed return flows

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[3] The San Antonio/Guadalupe and Nueces River Basin will involve additional runs and will be handled with specific requirements at another time.

[4] If a water right's special condition(s) are in conflict with the specification of the model runs, the special condition shall prevail. An example of this would be that if a water right has a special condition stating that the water right holder must return a specific quantity of water to the water course, the model should accommodate this condition in all runs, regardless of the specifications listed in the model runs.

[5] Assumed Return Flow – See Issue # 14.

No term water rights

RUN 6 - Modified diversion amounts (10 years of non-use = 0)
Authorized area capacity parameters
No assumed return flows
No term water rights

RUN 7 - Modified diversion amounts (max use for last 10 years)
Authorized area capacity parameters
No assumed return flows
No term water rights

CURRENT CONDITIONS RUN (term water availability)

RUN 8 - Modified diversion amounts (max use for last 10 years)
Year 2000 area capacity parameters
Assumed return flows
Term water rights

FIRM YIELD ANALYSIS

In addition to the eight runs described above, an additional analysis will be conducted to determine the firm yield of all major reservoirs that have consumptive water rights associated. If such major reservoir(s) are authorized any type of consumptive use other than municipal, a typical municipal demand distribution shall be applied to the annual authorized amount, for the purposes of this analysis.

Using the above described RUN3 parameters, each major reservoir that has consumptive water rights associated will be examined. If the RUN3 simulation did not produce a shortage, no additional analysis is required and the authorized amount is to be documented as the "permitted firm yield" of the reservoir. If the RUN 3 simulation resulted in a shortage for any time step in the period of record, the authorized amount for this water right will be reduced and the WRAP program will be run again. This process will be repeated until the simulated demand produces a minimum quantity of water in storage (at least 10 acre-feet). The resulting reduced demand will be documented as the "firm yield" of the reservoir.

Note that the demand is not allowed to exceed the amount authorized, even if a reservoir does not experience a shortage with the full authorized demand. This is because an increase in a water right's authorized amount would result in the increase being issued with a new priority date, and thus would not be available to the initial water right with the same simulated priority.

USE OF MODEL OUTPUT

The output of each of the model runs defined above will include the specific chart output for each water right of record identified earlier in this document. In addition, the output of the model should include a generalized report which includes a listing of unappropriated and regulated flows at a minimum of eight TNRCC Water Quality

Segment boundaries, the locations used in calculating naturalized flows, the most downstream control point in the basin, and other key locations throughout the basin which will be specified by the TNRCC, TWDB, and TPWD at a later date.

Instream flows will be simulated for all water rights containing such restrictions. Any water right that has a specific special condition for the protection of instream flows or inflows to the bays and estuaries will not be allowed to divert state water in any of the model runs until the specified restriction is met in the model. Because of Prior Appropriations, this requires all upstream junior water rights to be curtailed from diversion as well.

Each model run will have many control points besides water right locations. These include TNRCC water quality segment boundaries, USGS gaging stations, and other hydrologically significant locations each WAM contractor determines is needed. The regulated flow quantity can be specified as an output type for any/all control point locations in any of the model runs; thus, the impact on instream flows and bay and estuary inflows can be analyzed for all of the scenarios modeled in the 8 model runs.

13. Model Output for Water Right Holders (1/1/99)

Discussion:

The TNRCC must be able to address the questions posed by SB1 for each constructed run of the model. In addition, TNRCC must provide meaningful information to water right holders, the general public, and the scientific and professional community. While the simulated diversion output of WRAP indicates the specific amount of water a water right holder could divert in a model run for each period of record, it is not easy to decipher. The issue is to arrive at a concise report that is easy to produce from a WRAP run that could be mailed to every water right holder.

Risks:

The principle risk associated with this issue is the production of lengthy and/or difficult to understand model output that must be provided to every water right holder.

Benefits:

Concise and clearly understandable output will aid in achieving the goals of SB1. In addition, concise output will be easier and cheaper to produce and distribute.

Decision:

Parsons Engineering Science, Inc. will code a subroutine in the existing tables program for WRAP, or construct another post-WRAP program that will identify the drought of record for each water right of record based on the guidelines in these issues papers. The post-WRAP program code will also produce output for each water right of record. This single page, or at most two pages, of output will contain information identifying the water right holder, the specific run represented by the output, the simulated diversion information in table form, and two graphs of the simulated diversion information at the bottom of the page. The first graph is to be called "Diversion Time Series" and the other is to be called "Reliability Curve".

Diversion Time Series will show each year of the period of record on the X-axis and the annual simulated diversion expressed in acre-feet for each year of the period of record

on the Y-axis. The years determined to be drought will be highlighted or labeled in this graph.

Reliability Curve will show the percent of years on the X-axis and the percent of authorized demand met on the Y-axis.

16. Drought Year Calculation / Water Right Mailout (10/22/99)

Discussion:

Since the 76th legislature's passage of Senate Bill 657, the WAM's no longer have to identify the amount of water that is available to each water right holder "when flows are 75% of normal" and "when flows are 50% of normal". Rather, only the amount of water available to each water right during a drought year is now required. Consequently, Resolved Issue 8 (Normal Year Calculation) was appended with this resolved issue and logic was developed that enabled this type of information to be extracted from the WAM and sent to each water right of record.

In order to produce the water rights mailout output, a workable definition of "drought year" had to be developed. Since water availability during drought times greatly depends on type of use, demand distribution, type of diversion process (direct diversion, on-channel reservoir, etc), and other complicating factors, it was determined that the year in which the lowest simulated diversion was computed in the WAM would represent the drought year and the corresponding quantity that was diverted in this year would represent the amount of water available to each water right during a drought year. For water rights that are authorized storage with no right of diversion, simulated storage is substituted for diversion as the defining quantity.

Furthermore, it was determined that although this information could be obtained from any of the eight WAM runs, the use of RUN3 and RUN8 would be the most meaningful and useful runs to produce the water rights mailout.

19. Issue: RUN3 and RUN8 of the New WAMs Relating to the Review of New Perpetual Water Right Applications and Term Water Right Applications (04/18/00)

Discussion:

The TNRCC uses RUN3 of the new Water Availability Models (WAMs) as the run to review new perpetual water right application requests and requests for amendment of existing perpetual water rights. RUN3 simulates all water rights of record to their full authorized extent. Use of any other model run which simulates quantities less than that which is authorized by permit may result in over-appropriation of the State's surface water resources by issuing additional water rights based upon water that has already been authorized to senior perpetual water rights. The TNRCC uses RUN8 to review new term permit water right application requests and requests for amendment of existing term permit water rights. RUN8 simulates all basin water rights based upon the following estimates: water rights' reported maximum annual use in the last ten years; current sedimentation conditions in major reservoirs; and current diversion/return flow relationships.

Risks:

An inconsistent approach in consideration of the various WAM runs in the analyses of perpetual and term water right applications could result in inconsistent results across the state.

Benefits:

A consistent methodology using RUN3 to review new perpetual water right applications requests and requests for amendment of existing perpetual water rights will provide the WAM project with consistent results across the state, meeting the requirements of S.B. 1. A consistent use of RUN8 to review new term permit water right application requests and requests for amendment of existing term permit water rights will also ensure the WAM project with similar results that are consistent with the requirements of S.B. 1.

Decision:

RUN3 and RUN8 will be utilized as the official permitting runs for perpetual and term water rights applications for the WAM analyses to ensure consistent results across the state.