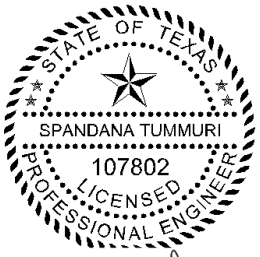
SAN JACINTO RIVER AUTHORITY RAW WATER SUPPLY MASTER PLAN
DETAILED STRATEGY EVALUATION TECHNICAL MEMORANDUM

Project Name:	Return Flows in Highlands Service Area
Project Type:	Reuse
Potential Supply Quantity (Rounded):	135,146 acre-feet/year (120 MGD)
Development Timeline:	5 years
Project Capital Cost:	NA
Unit Water Cost (Rounded):	NA



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STRATEGY DESCRIPTION

The San Jacinto River Authority (SJRA) is a wholesale water provider for various municipal, industrial, and irrigation retail customers in the San Jacinto River Basin. SJRA serves a substantial demand center of largely industrial water needs from its Highlands System. In the Highlands service area, water rights diverted at Lake Houston are SJRA's primary source of supply. SJRA also has water rights in the Trinity River Basin that were acquired from CLCND and the Devers Canal Company to be used as a source of supply to meet the Highlands service area demands. In terms of conveyance capacity, SJRA delivers the Lake Houston supplies by means of an extensive canal system. In addition to water rights and return flows diverted at Lake Houston, SJRA also contracts with Coastal Water Authority (CWA) to convey run-of-the-river water rights it owns in the lower Trinity River Basin to its Highland system. While the existing supplies are adequate to meet most of the current demand projections in the Highlands service area, there is also potential for exponential demand increases owing to rapid growth or industrialization. SJRA wants to plan and prepare for such eventuality and develop water supply strategies that help them serve the exponential growth, if needed.

Return flows are one of the various sources of supply that SJRA is considering as a potential future source. Throughout the San Jacinto River Basin, organized development is steadily overtaking the traditional, rural development that has historically been present in much of the area. Over time, homes with individual wells and on-site septic systems are being replaced with master-planned water and wastewater service. It is these latter types of development that produce opportunity for the development of return flows.

Below is a description of the methodology used to compute the return flows, as presented in Task 1102. The populations contributing to return flows were taken from the 2016 RWP and the Regional Groundwater Update Project (RGUP) developed by Houston Galveston Subsidence District (HGSD), Fort Bend Subsidence District (FBSD), and Lone Star Groundwater Conservation District (LSGCD), where possible. A detailed analysis of population density in utilities known to have a comprehensive wastewater system was conducted. The population densities for various utilities were determined and the lowest of these densities were used as a threshold for other population-bearing units; those with a density less than that will be assumed to utilize on-site treatment and will not generate return flow until they reach a density that surpasses the threshold. Based on review of per-capita demands from the RGUP and Region

H, the per-capita demands developed during the development of the 2016 Regional Water Plan (RWP) without the application of conservation were used to develop estimates of return flows. The return flow estimates were generated based on a return flow factor of 40% of the annual water demand. In addition, the return flows in the basin that are permitted under existing water rights were removed from consideration.

STRATEGY ANALYSES

The project analyses for Return Flows strategy for SJRA's Highlands service area include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Separate return flows strategies are being developed for the Montgomery County service area and the Highlands service area. Therefore, the sub-basins contributing return flows to each one of the service areas were identified and separated based on the service area to which they are contributing return flows. It is possible that the choice to develop certain return flows strategies may impact the potential to develop strategies downstream in the Highlands service area.

Exhibit 1 includes a map of the sub-basins contributing to the Highlands service area. Some or all of the return flows generated in the Montgomery County service area could potentially be diverted downstream to Lake Houston to serve the Highlands service area. This memorandum considers potential supplies discharged from the City of Conroe that may be captured upstream at the Lake Creek diversion point and used within Montgomery County, as described in the corresponding Montgomery County strategy. Other supplies included in this analysis are below this diversion point and are not readily developed for use in Montgomery County without additional considerations.

The overall potential volumes of return flows generated for the Highlands service area are reported in *Table 1* below.

Table 1. Summary of Return Flows Generated in the Highlands Service Area

Service Area	Return Flows (Acre-Feet per Year) [1]					
	2020	2030	2040	2050	2060	2070
Lake Houston	78,371	96,595	109,076	124,742	143,361	162,622
TOTAL	**78,371**	**96,595**	**109,076**	**124,742**	**143,361**	**162,622**

[1] Return flow estimates in this table do not include deductions for existing authorization or channel losses.

Any return flows already permitted under existing authorizations were subtracted from these return flows. *Table 2* includes a list of existing authorizations considered in this evaluation. The return flows to be deducted were determined based on the geographical extents of the existing authorizations and the manner in which they drain to potential diversion points. In addition to this, conveyance losses for the travel time from the sub-basins to the diversion points were also subtracted from the return flows listed in *Table 1* during the evaluation of supply options seen below. A channel loss factor of 5% was assumed and used for estimating these conveyance losses.

Table 2. Summary of Currently Authorized Return Flows Deducted from Highlands Service Area

Deduction	Return Flows (Acre-Feet per Year) [1]					
	2020	2030	2040	2050	2060	2070
City of Houston Permit 5827	5,254	5,576	5,896	6,188	6,459	6,594
River Plantation MUD	215	229	284	307	307	307
SJRA Permits 3960 and 5809 [2]	9,593	10,178	10,723	11,364	12,303	13,463
TOTAL	**15,062**	**15,983**	**16,903**	**17,859**	**19,069**	**20,364**

[1] Return flow estimates in this table do not include channel losses.
[2] Include flows that are utilized by SJRA as existing supplies.

The options considered below will use the return flows identified in *Table 1* along with the deductions indicated in *Table 2* in order to present potential scenarios in which flows may be developed for supply purposes. The options considered will develop water from resources that are not currently under consideration as presented in *Table 1*, less the volumes in negotiation/authorized in *Table 2*. Upstream options in the Lake Creek watershed will also be considered, should that strategy not be implemented for use in Montgomery County.

Return Flow Strategy Options

In order to develop the return flows in the Highlands service area, SJRA must determine the volume of return flows available in the Highlands service area, identify the entities that are generating those return flows, determine the pending applications for return flows to keep track of, establish agreements/contracts with entities generating return flows, and apply for TCEQ permit(s) for the return flows. SJRA has the following potential project alternatives.

1) Pending return flow permit application. Evaluate the volume of return flows that would be available to the Highlands service area from those pending applications.

2) Return flows originating in Montgomery County that flow to Lake Houston. This option will include entering into contractual agreements with dischargers in Montgomery County for the use of effluent and the permitting of those return flows. In some cases, this will be a continuation of the existing terms between SJRA and its GRP participants that make surface water-based return flows available. In other cases, SJRA will have to contract with parties in order to obtain rights to the reuse supply.

3) Other Flows to Lake Houston. SJRA will expand beyond Montgomery County to partner with others in developing reclaimed water supplies from municipal effluent.

Strategy Alternative Option 1 - The first return flow scenario for SJRA would be to track the pending return flow permit for the City of Conroe return flows submitted by SJRA. The permit application was submitted for 11,200 acre-feet. It is assumed that a percentage of this requested amount up to a maximum of 11,200 acre-feet will be available to SJRA to serve the Highlands service area, based on the availability of surface water-based return flows discharged by the Conroe facility. The projected volumes of return flows available from this pending application are listed in *Table 3* below, based on the assumption that SJRA's permitted return flows would not be diverted for use in Montgomery County but would pass to Lake Houston.

Table 3. Option 1: Return Flows Available in Highlands Service Area from Pending Applications

Reuse Source	Return Flows (Acre-Feet per Year) [1]					
	2020	2030	2040	2050	2060	2070
City of Conroe Permit	3,473	4,414	5,965	6,732	7,554	8,400
SJRA Surface Water	*3,473*	*4,414*	*5,965*	*6,732*	*7,554*	*8,400*
OPTION 1 TOTAL	**3,473**	**4,414**	**5,965**	**6,732**	**7,554**	**8,400**

[1] Return flows adjusted for channel losses.

Strategy Alternative Option 2 – Another return flow scenario for SJRA would be to permit flows originating in Montgomery County. This will involve coordinating with GRP Participants relying on surface water as well as those who rely on groundwater and establishing an agreement with those dischargers to permit for the return flows associated with them. This may involve contracts with parties who are not currently within the SJRA GRP and may belong to other GRPs within the county. It is also noteworthy that this may include the inclusion of parties who are not currently part of SJRA's GRP but may be added at a later point under the Safe Harbor GRP provision. *Table 4* includes a summary of the return flow volumes available to SJRA by coordinating with GRP Participants relying on surface water in Montgomery County.

Table 4. Option 2: Return Flows Available in Highlands Service Area from Montgomery

Reuse Source	Return Flows (Acre-Feet per Year) [1]					
	2020	2030	2040	2050	2060	2070
SJRA Surface Water	774	1,766	5,261	13,442	24,807	37,781
Other Sources	10,941	19,063	23,592	27,196	30,737	33,382
TOTAL	**11,715**	**20,830**	**28,853**	**40,637**	**55,544**	**71,164**

[1] Return flows adjusted for channel losses.

Strategy Alternative Option 3 – The final strategy option for SJRA would be to coordinate with the other county water users. This includes coordination with other regional water providers such as City of Houston, NHCRWA, and WHCRWA, but also water users in Liberty, San Jacinto, and Waller counties. Upon determining the volume of return flows contributed by these areas, SJRA can establish an agreement with these entities to permit for the return flows generated by them. *Table 5* includes a summary of the return flows generated by other counties.

Table 5. Option 3: Return Flows Available in Highlands Service Area from GRP Participants using Groundwater

Reuse Source	Return Flows (Acre-Feet per Year) [1]					
	2020	2030	2040	2050	2060	2070
Harris County	50,511	58,662	62,166	65,056	67,523	69,835
COH	*3,416*	*3,462*	*3,478*	*3,463*	*3,427*	*3,497*
NHCRWA	*43,735*	*47,254*	*50,143*	*52,578*	*54,706*	*56,640*
WHCRWA	*2,791*	*5,433*	*5,654*	*5,822*	*5,949*	*6,048*
Other	*570*	*2,514*	*2,891*	*3,193*	*3,441*	*3,651*
Other Counties	1,083	1,121	1,155	1,191	1,225	1,259
TOTAL	**51,594**	**59,783**	**63,321**	**66,247**	**68,748**	**71,095**

[1] Return flows adjusted for channel losses.

Because the return flows are naturally flowing into Lake Houston, there is no need for any additional infrastructure to capture any of the return flows discussed in the strategies above. To that end, the only cost incurred in developing these strategies is the administrative and legal fees associated with the TCEQ permitting process. SJRA must coordinate with the entities generating the return flows to determine the

timing for developing the return flows over the planning horizon. It should be noted that the return flows permitted in the strategy will represent an additional source of supply and must not be considered as part of SJRA's existing permit authorization for Lake Houston. These return flows are available to any entity that is wanting to permit the supplies. Therefore, the amount available may vary as additional permits are applied for by other entities. In addition to this, SJRA will have to coordinate with City of Houston for the bed and banks transfer of the return flows through Lake Houston. The current evaluation of this strategy accounted for all the known existing authorizations. The future analyses of this strategy must take into consideration any additional return flow authorizations secured or applied for with TCEQ.

Environmental Considerations

Environmental considerations associated with reuse are largely associated with the reduction of instream flows. This consideration will be included as part of the permitting process for any indirect reuse project. More specific issues arise from the development of infrastructure intended to facilitate the use of reclaimed water. The following are some of the general environmental considerations associated with the development of the return flows strategy in the Highlands service area.

The diversion of the effluent source supply would be expected to have some degree of impact in terms of reduction of instream flows downstream of the diversion point for any portion of the source supply originating from current levels of return flow. A more detailed analysis of environmental impacts and legal constraints would be considered during the permit application and review process, which has been initiated. Any impacts would be anticipated to occur from reuse of effluent generated from current levels of discharge; diversion of the portion attributable to future growth would not be expected to cause additional impact. It should also be noted that the proposed diversions would occur upstream of the monitoring points for Senate Bill 3 environmental flow standards and could potentially be subject to associated restrictions.

All environmental constraints can be addressed during the permitting and detailed feasibility study phases of the project development. At this stage, the environmental considerations are merely provided as a guide for selecting the appropriate route for future evaluation.

Permitting and Development

SJRA will have to coordinate with TCEQ for a bed and banks permit to convey the return flows developed in this strategy. SJRA will have to apply for authorization to use the bed and banks of Lake Houston to convey reuse supplies for subsequent diversion. SJRA will have to work with the entities generating return flows to negotiate contracts to capture and divert the return flows generated by these entities. It should be noted that the unpermitted return flows are currently contributing to City of Houston's Lake Houston and enhancing the lake yield during dry periods. SJRA will have to deal with the issues associated with the impact on the lake yield when some of these return flows are permitted. It is also understood that there is a potential shortage in the San Jacinto River Basin which is being fulfilled and managed through the return flows contributing to the water bodies in the basin. When these return flows are permitted, the shortages that were managed by means of the return flows should be addressed.

Cost Analysis

The primary costs incurred in developing this strategy are the administrative and legal/engineering fees associated with the procurement of the return flow permits. There will be some contractual costs incurred for implementing all the strategy options and these costs may include permitting fees, legal fees,

and contract fees with various entities. However, it is difficult to provide an estimate for these costs as each strategy cost will be different and varied on a case-to-case basis. Therefore, a cost estimate was not developed for this strategy. Although these costs cannot be determined at this time, there is likely some cost, arrangement, or legal fees inherent to contractual agreements with the multiple parties involved for several of the options described in this technical memorandum. The GRP Participants relying on surface water are one of the few with minimal issues since SJRA already has contractual relationships in place.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Return Flows in Highlands Service Area strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in *Table 6* below. Project criteria and scoring methodology are described in the technical memorandum *Preliminary Strategy Identification and Evaluation (Task 1104)*. Higher scores relate to preferable characteristics.

Table 6 - Screening Criteria and Scores for Return Flows in Highlands Service Area Strategy

Criteria	Rating		
	Option 1 Conroe Return Flows Permit	Option 2 Montgomery County Flows	Option 3 Other San Jacinto Flows
Cooperation	3	2	1
Cost	4	4	4
Diversification	3	3	3
Environmental	3	3	3
Funding	4	4	4
Land Acquisition	4	4	4
Legal	2	2	1
Location	4	4	4
Magnitude	2	4	4
Other Supplies	3	3	3
Public	3	3	3
Scalability	1	1	1
Schedule	4	3	3
Yield Risk	2	2	2
Weighted Score [1]	336	334	324

[1] Based on weighting methodology adopted in Preliminary Strategy Identification and Evaluation (Task 1104)

REFERENCES

Region H Water Planning Group. 2015. 2016 Regional Water Plan.

Walker
Grimes
Polk
San Jacinto
Montgomery
Liberty
Harris
Waller
LAKE LIVINGSTON
LAKE CONROE
LEWIS CREEK RESERVOIR
LAKE HOUSTON
Trinity River
San Jacinto River

Legend

Drainage Sub Basins
Lake Houston
Rivers
Existing Reservoirs
Counties

N
W E
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0 35,000 70,000
Feet

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DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas South Central
FILE NAME Exhibit_1_HighlandsSA_ReturnFlows_0915
PREPARED BY DML

SJRA RAW WATER SUPPLY MASTER PLAN
Highlands Service Area

Sub-Basins Contributing Return Flows

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EXHIBIT
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