GeoSystems Analysis, Inc.
Innovations in Hydrology

MEMORANDUM

April 23, 2020

TO: Michael Brinton, Stanislaus County Public Works (SPCW)
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FROM: Jason Keller, GSA
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CC: Frederic Clark, SCPW

RE: Technical Memorandum 2 - Dry Creek Watershed Stormwater Management and Groundwater Recharge Multiple Account Analysis

1.0 INTRODUCTION

GeoSystems Analysis, Inc. (GSA) has developed proposed key criteria for evaluating and comparing potential stormwater management sites identified in the Phase I Evaluation of Stormwater Management and Groundwater Recharge Projects in the Dry Creek Watershed (GSA, 2020). Fifteen (15) potential flood control and stormwater capture sites within the Dry Creek Watershed (DCW) were identified in the Phase I study. To evaluate the relative advantages and disadvantages of the different potential stormwater control sites, technical, economic, environmental and social/cultural factors for each site will be applied into a Multiple Account Analysis (MAA) evaluation matrix (Mendoza and Martins, 2006). The purpose of the MAA is to use the proposed criteria and assigned weighting values from which a score can be assigned to each potential site. This memo presents recommended MAA key criteria and weighting factor values for the DCW proposed stormwater control sites.

2.0 MULTIPLE ACCOUNT ANALYSIS METHODOLOGY

The MAA methodology considers a series of principal criteria (accounts) with a weighting value. Each account has different influence factors or sub-criteria (sub-accounts), which each have their own weighting value. Finally, for each sub-account, there are different indicators with their own weighting values. Once the indicators are established and their weighting values assigned, each site is analyzed, and value are assigned for the indicators, sub-accounts, and accounts to obtain a total weighting value per account, and the account values are then added to obtain the total value per site. The site with the highest value is considered the best option and thus an alternatives ranking can be formulated.

The MAA establishes a baseline for the evaluation of sites, provides a logical sequence of analysis and takes into consideration that certain indicators are more important or relevant than others. This is a subjective process given that the weighting values and accounts are provided based on the experience and professional criteria of GSA. The proposed weighting values may be revised based on comments from the Stanislaus County.

3.0 MULTIPLE ACCOUNT ANALYSIS MATRIX

Table 1 presents the proposed indicator scoring values. Scoring values are assigned for each indicator on a scale of 3 to -3 that covers seven classes. Table 2 provides a proposed weighting values for the accounts, sub-accounts, and indicator values. The comprehensive MAA evaluation matrix, incorporating technical, economic, environmental, social and cultural criteria is presented in Table 3. Description of each criteria is provided below. An example MAA evaluation is presented in Section 4.0.

Table 1. Indicator score values

Score Value	Description
3	Good
2	Moderately Good
1	Slightly Good
0	Neutral
-1	Slightly Poor
-2	Moderately Poor
-3	Poor

Table 2. Weighting values for accounts, sub-accounts, and indicators

Significance	Account and Sub-account Weighting Values	Indicator Weighting Values
Low Value	0.2	1
Moderately Low Value	0.4	2
Moderate Value	0.6	3
Moderately High Value	0.8	4
High Value	1.0	5

Table 3. Evaluation criteria matrix

Account	Account Weight	Sub-Account	Sub-Account Weight	Indicator	Indicator Weight
Technical	**1**	Surface Conditions	0.5	Soil permeability	5
				Geomorphology	4
				Topography	4
		Subsurface Conditions	0.5	Vadose zone permeability	5
				Depth to groundwater	5
				Aquifer transmissivity	4
		Surface Water	1	Flood protection	5
				Volumes detained	4
				Distance to recharge/use area	4
Economic	**0.8**	Cost	0.8	Capital cost (initial and long-term)	5
				Operation costs	5
Environmental	**0.6**	Wildlife/Habitat	0.5	Habitat improvement/ maintenance	4
		Water	1.0	Increased groundwater recharge	4
				Potential dilution of subsurface contaminants	4
		Regulatory	0.5	Permitting	4
Social and Cultural	**0.6**	Social	0.6	Reduced flood risk to DACs	5
				Recreational space opportunities	2
				Potential impact to landowners	5
		Cultural	0.4	Impacts to cultural resources	4
				Visual impacts	2

DAC – Disadvantaged Communities

3.1 Technical Criteria

Surface and subsurface conditions and surface water aspects and how they may affect the overall site alternatives are described below.

- Surface conditions
    - Soil permeability – Soil infiltration rates and associated recharge area necessary to meet target recharge volumes. Removal of low permeability surface soils or recharge enhancement (e.g. dry wells, infiltration galleries) needed.
    - Geomorphology – Pumping system needed to lift water out of channel to off-channel recharge system. Flow velocities sufficient to scour in-channel recharge system sediment deposits.

  - Topographic slopes – Will surface slope increase engineering design requirements of off-channel or in-channel recharge system.

- Subsurface conditions
  - Vadose zone permeability – Permeability of vadose zone sediments sufficient to transmit infiltrated water at the target rate. Low permeability layers present that may cause perching of infiltrated water.
  - Depth to groundwater – Available vadose zone thickness sufficient for groundwater storage.
  - Aquifer transmissivity – Capacity of the aquifer to convey recharged water laterally away from the site (i.e. minimize groundwater mounding).
- Surface water
  - Flood protection – Degree of flood protection offered by the recharge system.
  - Volumes detained – Volume of water detained and available for recharge.
  - Distance to recharge/use area – The (minimum) distance needed to convey water to the recharge area.

3.2 Economic Criteria

The economic component of the evaluation considers capital costs (initial and long-term) and operation and maintenance costs. Capital costs may include:

- Constructed in-channel water detention features (e.g. weirs, dams, levees)
- Diversion pump and piping
- Land acquisition/lease
- Constructed basin
- Monitoring equipment

Operation and maintenance costs may include:

- Power
- Surface clogging layer removal
- Vegetation control on constructed elements (e.g. basin berms)
- Surface and groundwater quality testing

3.3 Environmental Criteria

Environmental criteria provide indicators for enhancement of habitat, groundwater, and regulatory constraints.

- Wildlife/Habitat – Improvement of habitat for native wildlife (e.g. aquatic species, birds) and/or habitat maintenance (e.g. control of non-native vegetation species).

- Water
    - Increased groundwater recharge – Increased groundwater recharge and aquifer storage volumes.
    - Potential dilution of subsurface contaminants – Potential of recharged surface water to dilute existing subsurface contaminants.
    - Permitting – Regulatory permitting effort required to implement project.

3.4 Social and Cultural Criteria

Social and cultural criteria provide indicators for:

- Reduced flood risk to Disadvantaged Communities.
- Potential creation of recreation space (i.e. parks).
- Potential impacts to landowners, for example due to periodic inundation of their land.
- Impacts to cultural resources.
- Visual impacts due to changes to the scenic attributes of the landscape.

4.0 EXAMPLE MULTIPLE ACCOUNTS ANALYSIS

Three hypothetical stormwater capture sites are evaluated as an example of how MAA is implemented to evaluate potential sites within the DCW. Site A is an example of a site with good surface and subsurface conditions, Site B is an example of a site with good surface water conditions and reduced capital and operation costs, and Site C is similar to Site A, except it offers improved social and cultural impacts. Results are shown in tabular form in Table 4 and summarized in Figure 1. This example demonstrates the influence of weighting factors on the MAA results and indicates that Site B is optimal relative to Site A and Site C.

Table 4. Multiple Account Analysis results for three example sites

Account	Account Weight	Sub-Account	Sub-Account Weight	Indicator	Indicator Weight	Site A Slightly Poor Surface Water/Good Surface and Subsurface Conditions		Site B Good Surface Water Conditions / Moderately Good Cost		Site C Slightly Poor Surface Water/ Improved Social and Cultural Impacts	
Technical	1	Surface Conditions	0.5	Soil permeability	5	3	Good	1	Slightly Good	3	Good
				Geomorphology	4	3	Good	1	Slightly Good	3	Good
				Topography	4	3	Good	1	Slightly Good	3	Good
				Subaccount Rating		**3.00**		**1.00**		**3.00**	
				Weighted Subaccount Value		**0.75**		**0.25**		**0.75**	
		Subsurface Conditions	0.5	Vadose zone permeability	5	3	Good	1	Slightly Good	3	Good
				Depth to groundwater	5	3	Good	1	Slightly Good	3	Good
				Aquifer transmissivity	4	3	Good	1	Slightly Good	3	Good
				Subaccount Rating		**3.00**		**1.00**		**3.00**	
				Weighted Subaccount Value		**0.75**		**0.25**		**0.75**	
		Surface Water	1	Flood protection	5	-1	Slightly Poor	3	Good	-1	Slightly Poor
				Volumes detained	4	-1	Slightly Poor	3	Good	-1	Slightly Poor
				Distance to recharge/use area	4	-1	Slightly Poor	3	Good	-1	Slightly Poor
				Subaccount Rating		**-1.00**		**3.00**		**-1.00**	
				Weighted Subaccount Value		**-0.50**		**1.50**		**-0.50**	
				Account Rating		**1.00**		**2.00**		**1.00**	
				Account Value Weight		**0.33**		**0.67**		**0.33**	
Economic	0.8	Cost	0.8	Capital cost (initial and long-term)	5	1	Slightly Good	2	Moderately Good	1	Slightly Good
				Operation costs	5	1	Slightly Good	2	Moderately Good	1	Slightly Good
				Subaccount Rating		**1.00**		**2.00**		**1.00**	
				Weighted Subaccount Value		**1.00**		**2.00**		**1.00**	
				Account Rating		**1.00**		**2.00**		**1.00**	
				Account Value Weight		**0.27**		**0.53**		**0.27**	
Environmental	0.6	Wildlife/Habitat	0.5	Habitat improvement	4	1	Slightly Good	1	Slightly Good	1	Slightly Good
				Subaccount Rating		**1.00**		**1.00**		**1.00**	
				Weighted Subaccount Value		**0.25**		**0.25**		**0.25**	
		Water	1	Increased groundater recharge	4	3	Good	1	Slightly Good	3	Good
				Potential dilution of subsurface contaminants	4	0	Neutral	0	Neutral	0	Neutral
				Subaccount Rating		**1.50**		**0.50**		**1.50**	
				Weighted Subaccount Value		**0.75**		**0.25**		**0.75**	
		Regulatory	0.5	Permitting	4	1	Slightly Good	1	Slightly Good	1	Slightly Good
				Subaccount Rating		**1.00**		**1.00**		**1.00**	
				Weighted Subaccount Value		**0.25**		**0.25**		**0.25**	
				Account Rating		**1.25**		**0.75**		**1.25**	
				Account Value Weight		**0.25**		**0.15**		**0.25**	
Social and Cultural	0.6	Social	0.6	Reduced flood risk to DACs	5	1	Slightly Good	1	Slightly Good	2	Moderately Good
				Recreation space opportunities	2	-1	Slightly Poor	-1	Slightly Poor	2	Moderately Good
				Potential impact to landowners	5	-1	Slightly Poor	-1	Slightly Poor	2	Moderately Good
				Subaccount Rating		**-0.17**		**-0.17**		**2.00**	
				Weighted Subaccount Value		**-0.10**		**-0.10**		**1.20**	
		Cultural	0.4	Impacts to cultural resources	4	0	Neutral	0	Neutral	0	Neutral
				Visual impacts	2	-1	Slightly Poor	-1	Slightly Poor	0	Neutral
				Subaccount Rating		**-0.33**		**-0.33**		**0.00**	
				Weighted Subaccount Value		**-0.13**		**-0.13**		**0.00**	
				Account Rating		**-0.23**		**-0.23**		**1.20**	
				Account Value Weight		**-0.05**		**-0.05**		**0.24**	
TOTAL MATRIX SCORE						**0.80**		**1.30**		**1.09**	

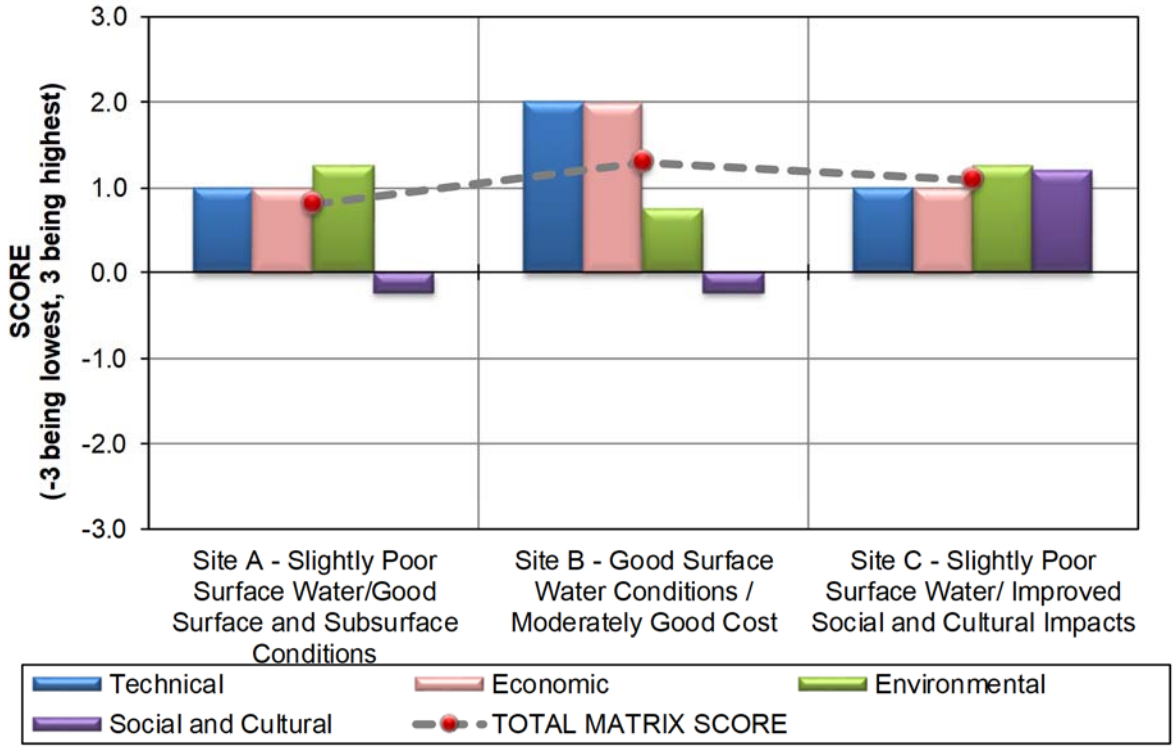

Figure 1. Multiple Accounts Analysis results for three example sites

5.0 CONCLUSIONS

The proposed MAA matrix and weighting values allow for quantifiable evaluation and comparison of the potential stormwater management sites within the DCW. The MAA is proposed to be used during the Phase II Evaluation of Stormwater Management and Groundwater Recharge Projects to select three priority sites for more detailed analysis. Weighting values proposed herein may require modification after consultation with Stanislaus County. A sensitivity analysis of the assigned weighting values can also be performed during the MAA to increase the reliability of the analysis.

6.0 REFERENCES

Mendoza, G.A. and H. Martins, 2006. Multi-criteria decision analysis in natural resource management: A critical review of methods and new modelling paradigms. Forest Ecology and Management. 230 (2006), pg 1-22.