

AGENDA  
IRVINE RANCH WATER DISTRICT  
SUPPLY RELIABILITY PROGRAMS COMMITTEE  
THURSDAY, APRIL 19, 2018

CALL TO ORDER    3:00 p.m., Committee Room, Second Floor, District Office  
15600 Sand Canyon Avenue, Irvine, California

ATTENDANCE    Committee Chair: Peer Swan    \_\_\_\_\_  
Member: Douglas Reinhart    \_\_\_\_\_

|                     |               |       |                   |       |
|---------------------|---------------|-------|-------------------|-------|
| <u>ALSO PRESENT</u> | Paul Cook     | _____ | Kellie Welch      | _____ |
|                     | Rob Jacobson  | _____ | Christine Compton | _____ |
|                     | Ray Bennett   | _____ | Paul Weghorst     | _____ |
|                     | Jo Ann Corey  | _____ | Dane Johnson      | _____ |
|                     | Fiona Sanchez | _____ | Christine Compton | _____ |
|                     | _____         | _____ | _____             | _____ |

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**COMMUNICATIONS**

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1. Notes: Weghorst
2. Public Comments
3. Determine the need to discuss and/or take action on item(s) introduced that came to the attention of the District subsequent to the agenda being posted.
4. Determine which items may be approved without discussion.

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**INFORMATION**

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- |    |                                                                                                                          |  |
|----|--------------------------------------------------------------------------------------------------------------------------|--|
| 5. | <u>WATER BANKING PROJECT FACILITIES, CAPACITIES, OPERATIONS, AND PROGRAMS OVERVIEW – JOHNSON/WELCH/SANCHEZ/ WEGHORST</u> |  |
|----|--------------------------------------------------------------------------------------------------------------------------|--|

Recommendation: Receive and file.

- |    |                                                                               |  |
|----|-------------------------------------------------------------------------------|--|
| 6. | <u>STRAND RANCH 2018 INFILTRATION STUDY – BENNETT/WELCH/ SANCHEZ/WEGHORST</u> |  |
|----|-------------------------------------------------------------------------------|--|

Recommendation: Receive and file.

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**OTHER BUSINESS**

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7. Directors' Comments

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**OTHER BUSINESS - Continued**

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8. CLOSED SESSION CONFERENCE WITH REAL PROPERTY NEGOTIATORS -  
Government Code Sec. 54956.8 - Related to Acquisition of Water Rights from the Dudley  
Ridge Water District and the Rosedale-Rio Bravo Water Storage District.

*IRWD negotiators:* Paul Cook, General Manager and Paul Weghorst, Executive Director of  
Water Policy.

*Negotiating parties:* Dudley Ridge Water District and Rosedale-Rio Bravo Water Storage  
District.

*Under negotiation:* Price and terms of payment of acquisition of water rights.

9. Adjourn

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Availability of agenda materials: Agenda exhibits and other writings that are disclosable public records distributed to all or a majority of the members of the above-named Committee in connection with a matter subject to discussion or consideration at an open meeting of the Committee are available for public inspection in the District's office, 15600 Sand Canyon Avenue, Irvine, California ("District Office"). If such writings are distributed to members of the Committee less than 72 hours prior to the meeting, they will be available from the District Secretary of the District Office at the same time as they are distributed to Committee Members, except that if such writings are distributed one hour prior to, or during, the meeting, they will be available at the entrance of the meeting room at the District Office. The Irvine Ranch Water District Committee Room is wheelchair accessible. If you require any special disability-related accommodations (e.g., access to an amplified sound system, etc.), please contact the District Secretary at (949) 453-5300 during business hours at least seventy-two (72) hours prior to the scheduled meeting. This agenda can be obtained in an alternative format upon written request to the District Secretary at least seventy-two (72) hours prior to the scheduled meeting.

April 19, 2018

Prepared by: D. Johnson/K. Welch

Submitted by: F. Sanchez/P. Weghorst *FSW*

Approved by: Paul A. Cook *PA Cook*

## SUPPLY RELIABILITY PROGRAMS COMMITTEE

### WATER BANKING PROJECT FACILITIES, CAPACITIES, OPERATIONS AND PROGRAMS OVERVIEW

#### SUMMARY:

Staff has prepared information related to IRWD's water banking facilities, capacities, exchange programs and operations that may serve as reference during Committee meetings. The information is presented in a format that can be updated as necessary to reflect changes in IRWD's projects, programs and operations. At the Committee meeting, staff will review this information and provide an update on ongoing efforts to secure additional water for recharge at IRWD's water banking projects as well as expected recovery operations for the year.

#### BACKGROUND:

To assist with the facilitation of Committee meeting discussions, staff has prepared reference materials in tabular, map and schematic formats that describe IRWD's water banking facilities, capacities, operations and exchange programs. The reference materials will be updated, as needed, to reflect changes to the projects, programs and operations. Following is an overview of the reference materials provided. Information is also provided regarding IRWD's 2018 water banking operations.

#### Capacity and Operations Tables:

A table presenting storage, recharge and recovery capacities of existing and planned IRWD water banking projects, including capacities available to IRWD in the Kern Water Bank, is attached as Exhibit "A". Exhibits "B" and "C" provide an update on water banking recovery and recharge operations and the balance of the water stored in the Kern Water Bank. Exhibit "B" provides before-loss estimates of water recharged at the water banking projects, and Exhibit "C" provides after-loss estimates of water recharged at the projects. Both Exhibits "B" and "C" include a column that provides totals for each water type and storage location.

#### 2018 Recharge Opportunities:

Staff has been pursuing additional opportunities to secure recharge water for 2018. At the Committee meeting, staff will provide an update on efforts to secure water from:

- Dudley Ridge Water District (DRWD);
- Antelope Valley-East Kern Water Agency;
- Metropolitan Water District of Southern California; and
- Other Opportunities.

2018 Recovery Operations:

Buena Vista Water Storage District (BVWSD) has requested recovery of its 6,144 AF of water that was stored at the Strand Ranch in 2017. Staff is working with operators at Rosedale-Rio Bravo Water Storage District (Rosedale) on responding to BVWSD's request and obtaining transaction request form approval from the Kern County Water Agency. Once staff receives approval for the transaction, Rosedale will initiate recovery and delivery of BVWSD's water using the wells at the Strand and Stockdale West Integrated Banking Projects.

Project Maps:

To support the tables provided as Exhibits "A", "B", and "C", staff has prepared maps that depict project wells and pipelines, recharge basins and CVC turnout locations, along with most recent recharge rates. These maps are provided as Exhibits "D", "E", and "F", respectively. The facilities shown on these maps are associated with the Strand Ranch, Stockdale West, Stockdale East and Rosedale-Rio Bravo Water Storage District (Rosedale) Drought Relief Projects.

Program Agreement Diagrams:

Schematic diagrams have been prepared that depict the IRWD water banking and exchange programs with Rosedale, BVWSD, DRWD, and Metropolitan Water District of Southern California. These diagrams are provided as Exhibits "G", "H", "I", "J", and "K" as described in the List of Exhibits.

FISCAL IMPACTS:

None.

ENVIRONMENTAL COMPLIANCE:

Not applicable.

RECOMMENDATION:

Receive and file.

LIST OF EXHIBITS:

Exhibit "A" – Recharge, Storage and Recovery Capacities of Current and Anticipated Water Banking Projects

Exhibit "B" – Water Banking Storage, Recharge and Recovery Operations before Losses

Exhibit "C" – Water Banking Storage, Recharge and Recovery Operations after Losses

Exhibit "D" – Map of Water Banking Project Wells and Pipelines

Exhibit "E" – Map of Water Banking Recharge Basins and Cross Valley Canal Turnout Facilities

Exhibit "F" – Map of Water Banking Recharge Rates

Exhibit "G" – Diagram of IRWD-Rosedale Water Banking and Exchange Program Agreements

- Exhibit “H” – Diagram of Long-Term Water Exchange Program with Buena Vista Water Storage District and Diagram of One-Year Program to Augment Recharge Using Stockdale West Recharge Facilities with Buena Vista Water Storage District
- Exhibit “I” – Diagram of Unbalanced Exchange Program Diagram with DRWD
- Exhibit “J” – Diagram of Coordinated Operating, Water Storage, Exchange and Delivery Agreement with Metropolitan
- Exhibit “K” – Diagram of Template Wheeling Agreement with Metropolitan

# Exhibit "A"

**TABLE 1**  
**Current and Anticipated Water Banking Projects**  
**Recharge, Storage and Recovery Capacities**  
**April 19, 2018**

| WATER BANKING PROJECT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | OWNERSHIP AND WELL INFO |                |                                | ALLOCATED CAPACITY (AF) |                                          |                                          |                                          |                                          | 1 <sup>st</sup> PRIORITY RECOVERY CONDITIONS (CFS) |                                                                 | 2 <sup>nd</sup> PRIORITY RECOVERY CONDITIONS (CFS) |                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|----------------|--------------------------------|-------------------------|------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|----------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------|--------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | IRWD OWNED              | WELLS EXISTING | WELLS PROPOSED OR UNDER CONST. | TOTAL STORAGE CAPACITY  | ANNUAL RECHARGE 1 <sup>ST</sup> PRIORITY | ANNUAL RECHARGE 2 <sup>ND</sup> PRIORITY | ANNUAL RECOVERY 1 <sup>ST</sup> PRIORITY | ANNUAL RECOVERY 2 <sup>ND</sup> PRIORITY | RECOVERY CAPACITY AS PLANNED <sup>1</sup>          | ESTIMATED RECOVERY CAPACITY (DEC. 2016 CONDITIONS) <sup>2</sup> | RECOVERY CAPACITY AS PLANNED                       | RECOVERY CAPACITY CURRENT CONDITIONS |
| Strand Ranch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Yes                     | 7              | -                              | 50,000                  | 17,500                                   | -                                        | 17,500                                   | -                                        | 40.0                                               | 27.0                                                            | -                                                  | -                                    |
| Stockdale West                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Yes                     | 3              | -                              | 26,000                  | 27,100                                   | -                                        | 11,250                                   | -                                        | 15.0                                               | -                                                               | -                                                  | -                                    |
| Stockdale East                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | No                      | -              | 2                              | -                       | -                                        | 19,000                                   | -                                        | 7,500                                    | -                                                  | -                                                               | 10.0                                               | -                                    |
| IRWD Acquired Storage Account <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | No                      | -              | -                              | 50,000                  | -                                        | -                                        | -                                        | -                                        | -                                                  | -                                                               | -                                                  | -                                    |
| Drought Relief Project Wells <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | No                      | -              | 3                              | -                       | -                                        | -                                        | -                                        | -                                        | 15.0                                               | -                                                               | -                                                  | -                                    |
| Kern Water Bank Storage Account <sup>5</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | No                      | -              | -                              | 9,495                   | 3,200                                    | -                                        | 6,330                                    | -                                        | -                                                  | -                                                               | -                                                  | -                                    |
| <b>TOTALS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                         | <b>10</b>      | <b>5</b>                       | <b>126,000</b>          | <b>44,600</b>                            | <b>19,000</b>                            | <b>28,750</b>                            | <b>7,500</b>                             | <b>70.0</b>                                        | <b>27.0</b>                                                     | <b>10.0</b>                                        | <b>0.0</b>                           |
| Partner Capacities <sup>4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                         |                |                                | 36,000                  | 22,300                                   | 9,500                                    | 12,000                                   | 0                                        | 35.5                                               | 27.0                                                            | -                                                  | -                                    |
| IRWD Capacities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                         |                |                                | 90,000                  | 22,300                                   | 9,500                                    | 16,750                                   | 7,500                                    | 34.5                                               | 0.0                                                             | -                                                  | -                                    |
| IRWD's recovery <i>during</i> 6 month partner recovery period (AF)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                         |                |                                |                         |                                          |                                          |                                          |                                          | 12,420                                             | 0.0                                                             | -                                                  | -                                    |
| IRWD's recovery <i>after</i> 6 month partner recovery period (AF)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                         |                |                                |                         |                                          |                                          |                                          |                                          | 4,330                                              | 6,733                                                           | -                                                  | -                                    |
| <b>TOTALS (AF)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                         |                |                                |                         |                                          |                                          |                                          |                                          | <b>16,750</b>                                      | <b>6,733</b>                                                    | <b>-</b>                                           | <b>-</b>                             |
| Number of months needed to recover IRWD's total AF after partners' recovery<br>(Assumes IRWD has use of total recovery capacity after partners' recovery)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                         |                |                                |                         |                                          |                                          |                                          |                                          | 8.1                                                | 14.0                                                            | -                                                  | -                                    |
| <sup>1</sup> Based on designed Strand recovery capacity assuming 370' bgs. Assumes 5 cfs for each of the Stockdale West and Drought Relief wells in order to meet IRWD's Water Banking, Transfers, and Wheeling policy position. Assumes partners' water is recovered over 6 months.<br><sup>2</sup> Strand Ranch wells currently idle.<br><sup>3</sup> IRWD has use of Acquired Storage and Drought Relief Project wells until January 12, 2039, unless the term of the agreement is extended.<br><sup>4</sup> One half of storage capacity at Stockdale West and Strand Ranch will be allocated for partners.<br><sup>5</sup> Kern Water Bank capacities based on 6.58% of Dudley Ridge Water District's 9.62% share of the Kern Water Bank. Annual recharge amount is based on an average of recharge rates for high and low groundwater level conditions. Not included in storage capacity, recharge, and recovery totals to match IRWD's Water Banking Policy Position Paper (10/26/2015). |                         |                |                                |                         |                                          |                                          |                                          |                                          |                                                    |                                                                 |                                                    |                                      |

# Exhibit "B"

**TABLE 2**  
**IRWD's Water Banking Storage, Recharge and Recovery Operations - BEFORE LOSSES**  
 April 19, 2018

| TRANSACTIONS                            | WATER BANKING ENTITY |                      |                     |                      |                                                    | TOTAL BY WATER TYPE<br>AND STORAGE<br>LOCATION |
|-----------------------------------------|----------------------|----------------------|---------------------|----------------------|----------------------------------------------------|------------------------------------------------|
|                                         | IRWD                 |                      | BUENA VISTA (BVWSD) | CENTRAL COAST (CCWA) | DUDLEY RIDGE WATER<br>DISTRICT (DRWD) <sup>3</sup> |                                                |
|                                         | SWP <sup>1</sup>     | NON-SWP <sup>2</sup> | NON-SWP             | SWP                  | SWP                                                |                                                |
| BEGINNING WATER IN STORAGE 2017 (AF)    |                      |                      |                     |                      |                                                    |                                                |
| Total Kern Water Bank                   | -                    | 4,581                | -                   | -                    | -                                                  | 4,581                                          |
| Total MWD System <sup>4</sup>           | 8,873                | -                    | -                   | -                    | 1,174                                              | 10,047                                         |
| Total Kern County                       | 437                  | 10,835               | -                   | -                    | -                                                  | 11,272                                         |
| TOTAL STORED WATER (1/1/2016)           | 9,310                | 15,416               | -                   | -                    | 1,174                                              | 25,900                                         |
| (RECOVERY) AND RECHARGE IN 2017 (AF)    |                      |                      |                     |                      |                                                    |                                                |
| Kern Water Bank Deliveries              | -                    | 75                   | -                   | -                    | -                                                  | 75                                             |
| 2017 SWP Allocation (85%) <sup>3</sup>  | 787                  | -                    | -                   | -                    | 787                                                | 1,574                                          |
| 2017 SWP Article 21 <sup>5</sup>        | 1,744                | -                    | -                   | -                    | 1,744                                              | 3,488                                          |
| SWP Table A (CCWA 2017 Exch.)           | 289                  | -                    | -                   | 289                  | -                                                  | 578                                            |
| High Flow Kern River                    | -                    | 6,827                | 6,827               | -                    | -                                                  | 13,654                                         |
| MWD Water to Jackson Ranch <sup>6</sup> | -                    | -                    | -                   | -                    | (143)                                              | (143)                                          |
| TOTAL 2016 TRANSACTIONS                 | 2,820                | 6,902                | 6,827               | 289                  | 2,388                                              | 19,226                                         |
| Total Kern Water Bank                   | -                    | 4,656                | -                   | -                    | -                                                  | 4,656                                          |
| Total MWD System                        | 8,873                | -                    | -                   | -                    | 1,174                                              | 10,047                                         |
| Total Kern County                       | 3,257                | 17,662               | 6,827               | 289                  | 2,388                                              | 30,423                                         |
| TOTAL STORED WATER (1/1/2018)           | 12,130               | 22,318               | 6,827               | 289                  | 3,562                                              | 45,126                                         |
| (RECOVERY) AND RECHARGE IN 2018 (AF)    |                      |                      |                     |                      |                                                    |                                                |
| Kern Water Bank Deliveries              | -                    | -                    | -                   | -                    | -                                                  | -                                              |
| 2018 SWP Allocation (20%) <sup>3</sup>  | 175                  | -                    | -                   | -                    | 175                                                | 350                                            |
| TOTAL ESTIMATED 2018 TRANSACTIONS       | 175                  | -                    | -                   | -                    | 175                                                | 350                                            |
| ESTIMATED WATER IN STORAGE 2018 (AF)    |                      |                      |                     |                      |                                                    |                                                |
| Total Kern Water Bank                   | -                    | 4,656                | -                   | -                    | -                                                  | 4,656                                          |
| Total MWD System                        | 8,873                | -                    | -                   | -                    | 1,174                                              | 10,047                                         |
| Total Kern County                       | 3,432                | 17,662               | 6,827               | 289                  | 2,563                                              | 30,773                                         |
| TOTAL ESTIMATED STORED WATER TO DATE    | 12,305               | 22,318               | 6,827               | 289                  | 3,737                                              | 45,476                                         |

**NOTES:**

-MWD = Metropolitan Water District of Southern California.

<sup>1</sup> IRWD's SWP includes 437 AF from CVWD that stays in Kern County.

<sup>2</sup> IRWD's Non-SWP total includes 3,158 AF of Kern County Water Agency Article 21 Water.

<sup>3</sup> DRWD water supply will be returned by MWD or IRWD's Strand Ranch to IRWD's Jackson Ranch. IRWD's 2013-2016 SWP allocation amounts are stored in the MWD system.

IRWD's 2017 SWP allocation water is stored in Kern County; assumes 2018 SWP water will be stored in Kern County.

<sup>4</sup> Beginning balance of water stored in MWD system includes 4,494 AF 2014 Exchange, 3,206 AF 2014 borrowed SWP, 649 AF IRWD's 2013-2016 SWP allocations through DRWD.

<sup>5</sup> Article 21 was delivered to Strand Ranch/Stockdale West from 3/8/17 - 3/22/17. Deliveries made pursuant to the DRWD/MWD Unbalanced Exchange Program.

<sup>6</sup> Water returned to Kings County by MWD for use on IRWD's Jackson Ranch.

# Exhibit "C"

**TABLE 3**  
**IRWD's Water Banking Storage, Recharge and Recovery Operations - AFTER LOSSES**  
 April 19, 2018

| TRANSACTIONS                                   | WATER BANKING ENTITY |                      |                     |                      |                                                    | TOTAL BY WATER TYPE<br>AND STORAGE<br>LOCATION |
|------------------------------------------------|----------------------|----------------------|---------------------|----------------------|----------------------------------------------------|------------------------------------------------|
|                                                | IRWD                 |                      | BUENA VISTA (BVWSD) | CENTRAL COAST (CCWA) | DUDLEY RIDGE WATER<br>DISTRICT (DRWD) <sup>1</sup> |                                                |
|                                                | SWP <sup>1</sup>     | NON-SWP <sup>2</sup> | NON-SWP             | SWP                  | SWP                                                |                                                |
| BEGINNING WATER IN STORAGE 2017 (AF)           |                      |                      |                     |                      |                                                    |                                                |
| Total Kern Water Bank                          | -                    | 4,165                | -                   | -                    | -                                                  | 4,165                                          |
| Total MWD System <sup>4</sup>                  | 7,917                | -                    | -                   | -                    | 1,174                                              | 9,091                                          |
| Total Kern County                              | 389                  | 9,675                | -                   | -                    | -                                                  | 10,064                                         |
| TOTAL STORED WATER (1/1/2016)                  | 8,306                | 13,840               | -                   | -                    | 1,174                                              | 23,320                                         |
| (RECOVERY) AND RECHARGE IN 2017 (AF)           |                      |                      |                     |                      |                                                    |                                                |
| Kern Water Bank Deliveries                     | -                    | 68                   | -                   | -                    | -                                                  | 68                                             |
| 2017 SWP Allocation (85%) <sup>3</sup>         | 669                  | -                    | -                   | -                    | 708                                                | 1,377                                          |
| 2017 SWP Article 21 <sup>5</sup>               | 1,479                | -                    | -                   | -                    | 1,566                                              | 3,044                                          |
| SWP Table A (CCWA 2017 Exch.)                  | 246                  | -                    | -                   | 246                  | -                                                  | 491                                            |
| High Flow Kern River                           | -                    | 5,803                | 6,144               | -                    | -                                                  | 11,947                                         |
| MWD Water to Jackson Ranch <sup>6</sup>        | -                    | -                    | -                   | -                    | (143)                                              | (143)                                          |
| TOTAL 2016 TRANSACTIONS                        | 2,393                | 5,871                | 6,144               | 246                  | 2,131                                              | 16,784                                         |
| Total Kern Water Bank                          | -                    | 4,233                | -                   | -                    | -                                                  | 4,233                                          |
| Total MWD System                               | 7,917                | -                    | -                   | -                    | 1,174                                              | 9,091                                          |
| Total Kern County                              | 2,782                | 15,478               | 6,144               | 246                  | 2,131                                              | 26,780                                         |
| TOTAL STORED WATER (1/1/2018)                  | 10,699               | 19,711               | 6,144               | 246                  | 3,305                                              | 40,104                                         |
| (RECOVERY) AND RECHARGE IN 2018 (AF)           |                      |                      |                     |                      |                                                    |                                                |
| Kern Water Bank Deliveries                     | -                    | -                    | -                   | -                    | -                                                  | -                                              |
| 2018 SWP Allocation (20%) <sup>3</sup>         | 149                  | -                    | -                   | -                    | 149                                                | 298                                            |
| TOTAL ESTIMATED 2018 TRANSACTIONS <sup>7</sup> | 149                  | -                    | -                   | -                    | 149                                                | 298                                            |
| ESTIMATED WATER IN STORAGE 2018 (AF)           |                      |                      |                     |                      |                                                    |                                                |
| Total Kern Water Bank                          | -                    | 4,233                | -                   | -                    | -                                                  | 4,233                                          |
| Total MWD System                               | 7,917                | -                    | -                   | -                    | 1,174                                              | 9,091                                          |
| Total Kern County                              | 2,931                | 15,478               | 6,144               | 246                  | 2,280                                              | 27,078                                         |
| TOTAL ESTIMATED STORED WATER TO DATE           | 10,848               | 19,711               | 6,144               | 246                  | 3,454                                              | 40,402                                         |

**NOTES:**

-Water in storage has been adjusted to account for losses. IRWD's water stored in Kern County is adjusted 15% for losses (5% for out of county loss, 6% surface loss, and 4% reserve loss); Water stored for DRWD and BVWSD in Kern County is adjusted 10% (6% for surface loss and 4% for reserve loss); KWB losses are 10%; no losses for water directly delivered to MWD system.

-MWD = Metropolitan Water District of Southern California.

<sup>1</sup> IRWD's SWP includes 389 AF from CVWD that stays in Kern County.

<sup>2</sup> IRWD's Non-SWP total includes 2,842 AF of Kern County Water Agency Article 21 Water.

<sup>3</sup> DRWD water supply will be returned by MWD or IRWD's Strand Ranch to IRWD's Jackson Ranch. IRWD's 2013-2016 SWP allocation amounts are stored in the MWD system.

IRWD's 2017 SWP allocation water is stored in Kern County.

<sup>4</sup> Beginning balance of water stored in MWD system includes (net of CVC losses) 3,920 AF 2014 Exchange, 2,824 AF 2014 borrowed SWP, 649 AF IRWD's 2013-2016 SWP allocations through DRWD.

<sup>5</sup> Article 21 was delivered to Strand Ranch/Stockdale West from 3/8/17 - 3/22/17. Deliveries made pursuant to the DRWD/MWD Unbalanced Exchange Program. 9 AF of additional CVC losses, split among IRWD and DRWD, are reflected in these amounts.

<sup>6</sup> Water returned to Kings County by MWD for use on IRWD's Jackson Ranch.



Irvine Ranch  
WATER DISTRICT

## Location Map: IRWD Water Banking Projects Wells and Turnin Pipelines

### MAP FEATURES

- Existing Extraction Well
- Planned Extraction Well
- Well Under Construction
- Well Discharge Pipelines
- Stockdale East
- Stockdale West
- Strand Ranch

This figure shows the location of IRWD's water banking project sites as well as existing and proposed extraction wells.

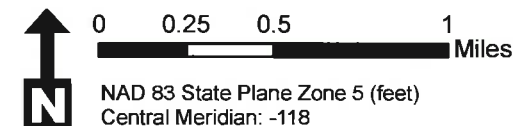


Exhibit "D"

Rosedale Highway

Drought Relief Project

Enos Ln

Stockdale Highway

Stockdale  
West

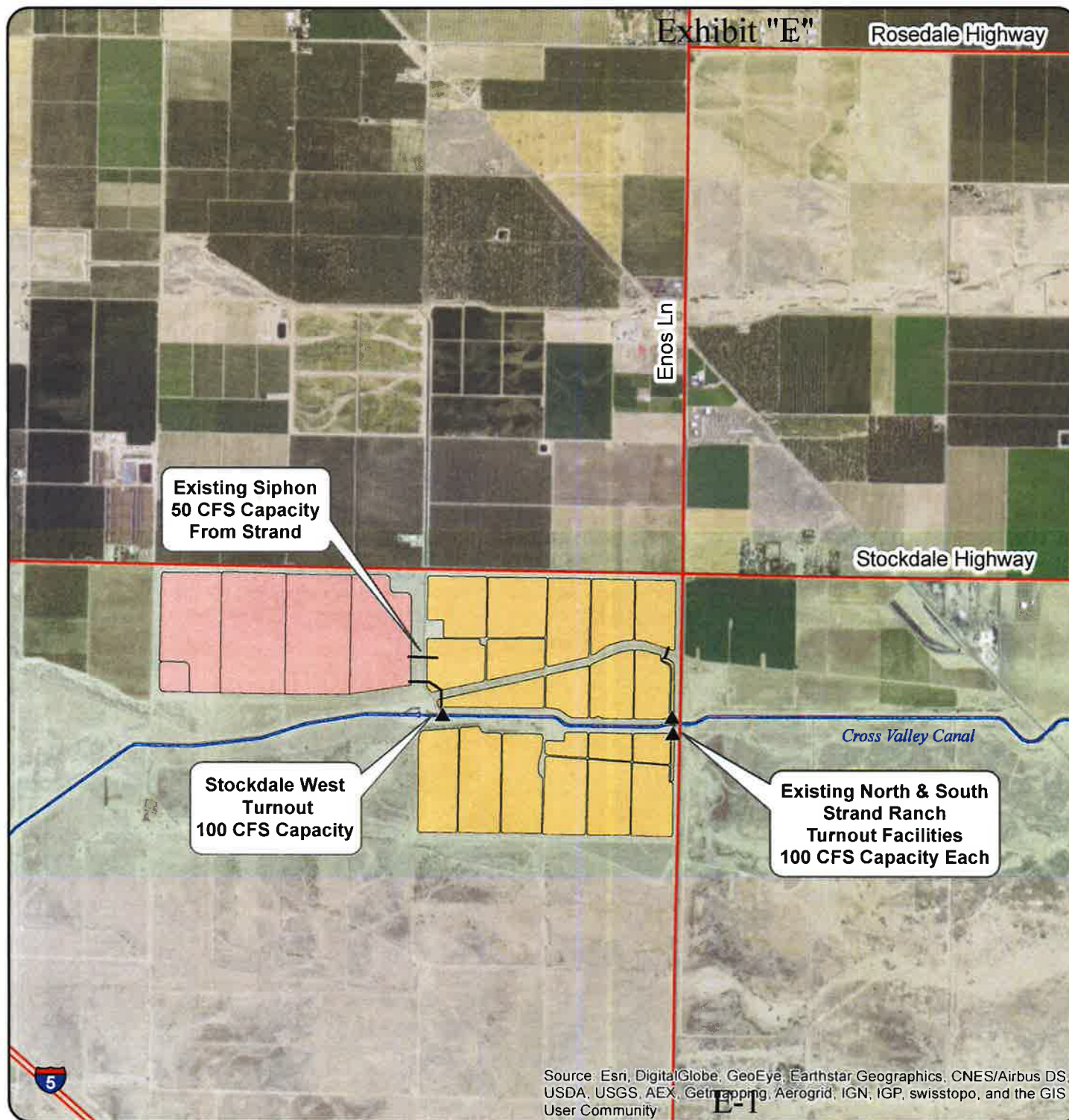
Stockdale  
East

Cross Valley Canal

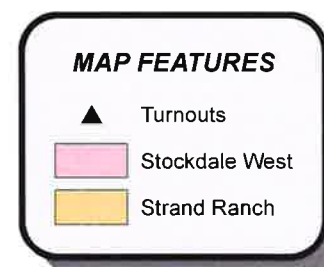
Strand Ranch

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

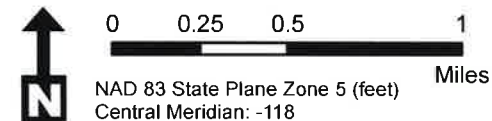
D-1

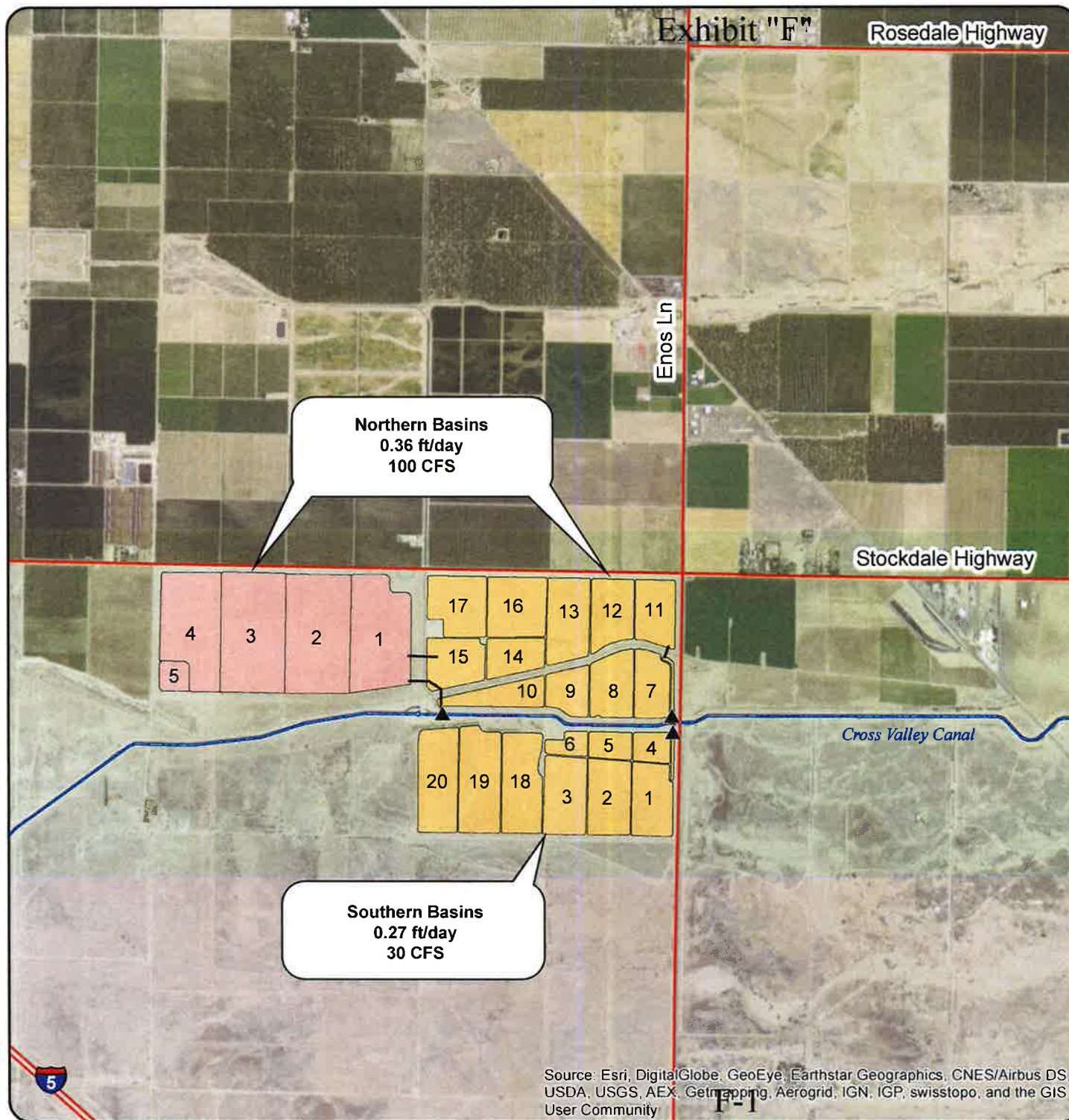


**Location Map:  
IRWD Water Banking Projects  
Recharge Basins & Turnout  
Facilities**



This figure shows the location of recharge basins as well as existing and anticipated pipelines and turnout facilities.



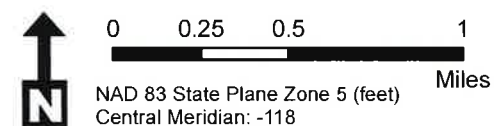


## Location Map: IRWD Water Banking Projects Recharge Rates

### MAP FEATURES

- ▲ Turnouts
- Stockdale West
- Strand Ranch

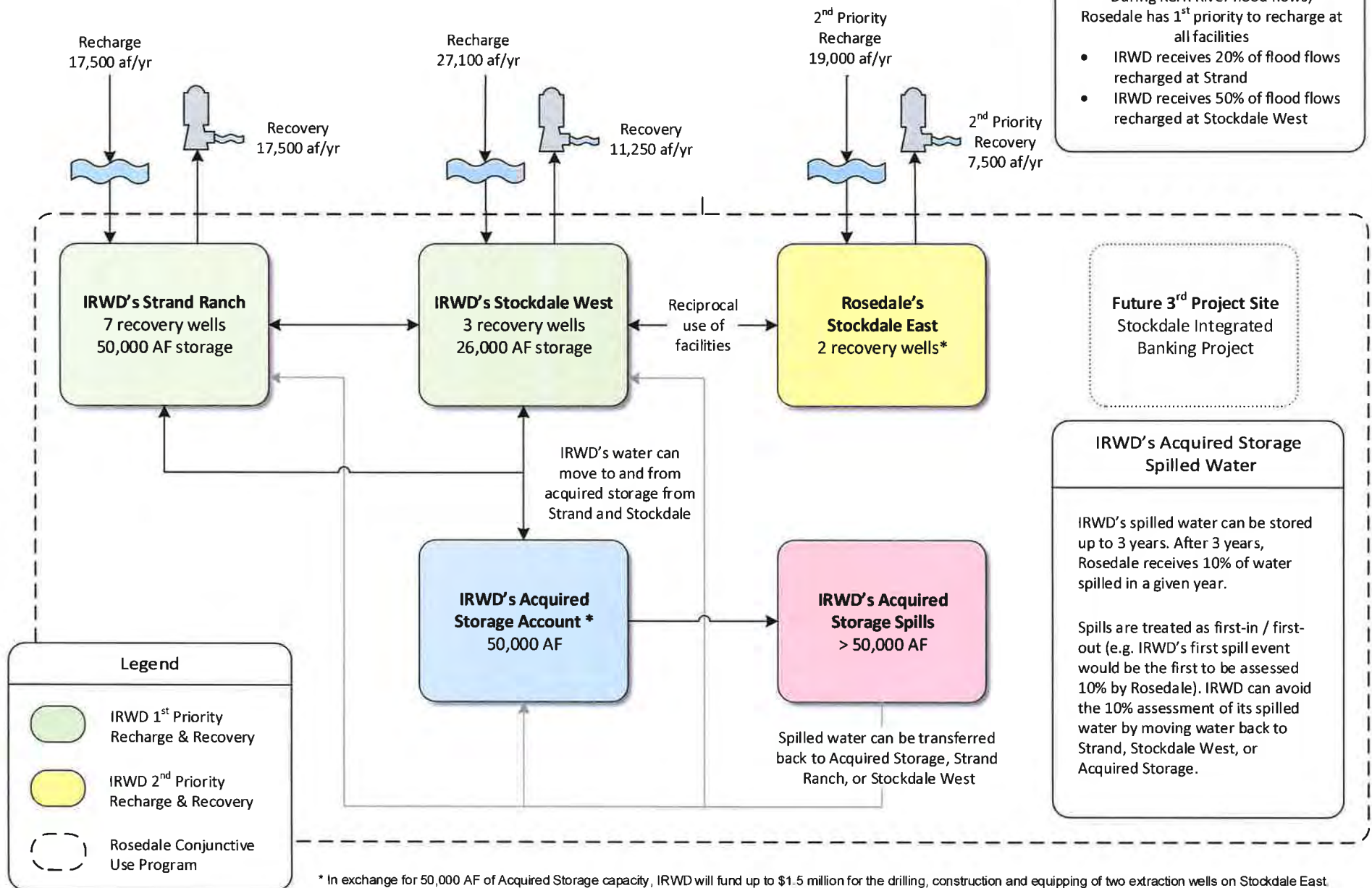
This figure shows the location of recharge basins and their associated recharge rates as of early December 2017. Recharge rates for Basins 4, 5, and 6 will be updated at the conclusion of the Pond Infiltration Study.



# Exhibit "G"

## IRWD-Rosedale Water Banking and Exchange Program Agreements

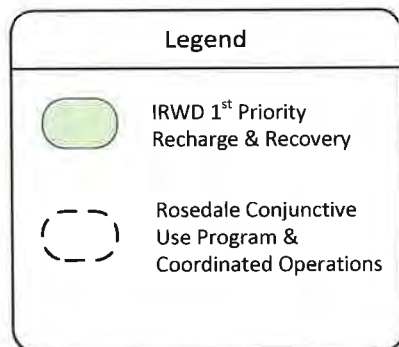
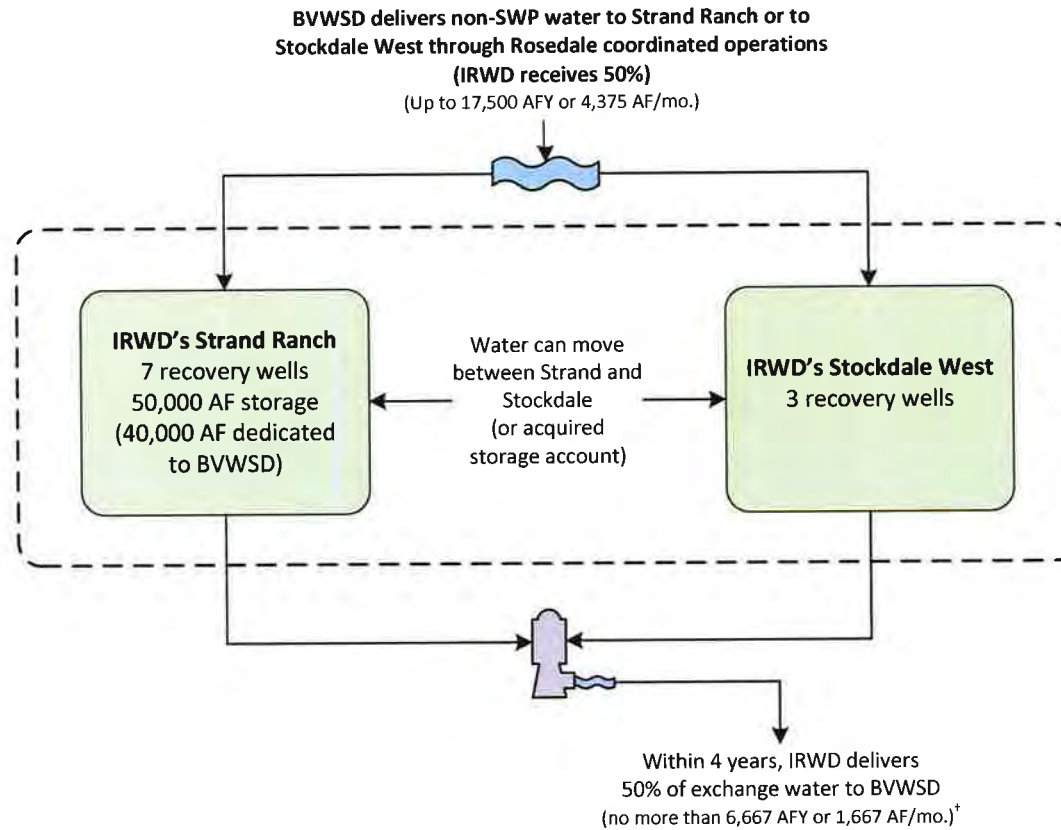
Effective 1/12/2009 through 1/12/2039 (Strand Ranch)  
2/4/2016 through 1/12/2039 (Stockdale West)



# Exhibit "H"

## Buena Vista Water Storage District Long Term Water Exchange Program

Effective 1/1/2011 through 1/12/2039

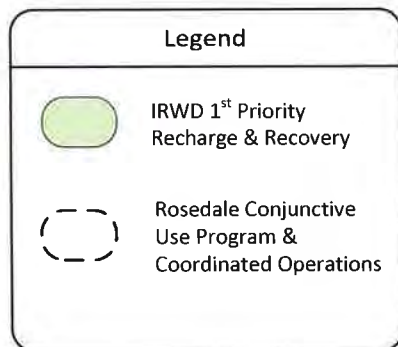
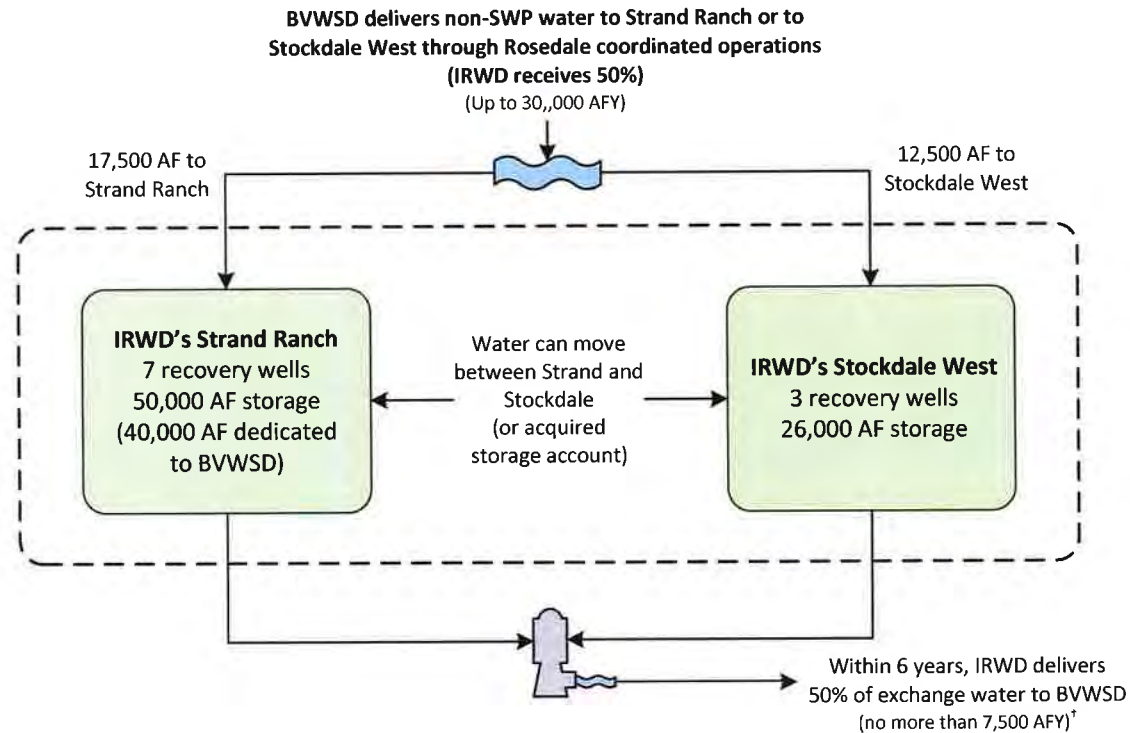


<sup>†</sup>IRWD shall remit one-half of the exchanged supply less one-half of reasonable losses back to BV no later than December 31<sup>st</sup> of the 4<sup>th</sup> year following the associated recharge event. IRWD pays for recovery of water returned to BV. Water to be remitted back to BV may remain in storage at Strand Ranch beyond the 4<sup>th</sup> year, in exchange for a greater percent being transferred to IRWD as compensation per the table shown to the right:

| Year Following Recharge Event | Percent Transferred to IRWD | Percent Returned to BV During or Before Indicated Year |
|-------------------------------|-----------------------------|--------------------------------------------------------|
| 1                             | 50%                         | 50%                                                    |
| 2                             | 50%                         | 50%                                                    |
| 3                             | 50%                         | 50%                                                    |
| 4                             | 50%                         | 50%                                                    |
| 5                             | 60%                         | 40%                                                    |
| 6                             | 70%                         | 30%                                                    |
| 7                             | 80%                         | 20%                                                    |
| 8                             | 90%                         | 10%                                                    |
| 9                             | 100%                        | 0%                                                     |

# Exhibit "H"

## Buena Vista Water Storage District One-Year Program to Augment Recharge Using Stockdale West Recharge Facilities Effective 4/1/2017 through 3/20/2018



<sup>†</sup>IRWD shall remit one-half of the exchanged supply less one-half of reasonable losses back to BV no later than December 31<sup>st</sup> of the 6<sup>th</sup> year following the associated recharge event. IRWD pays for recovery of water returned to BV. Water to be remitted back to BV may remain in storage at Strand Ranch beyond the 6<sup>th</sup> year, in exchange for a greater percent being transferred to IRWD as compensation per the table shown to the right:

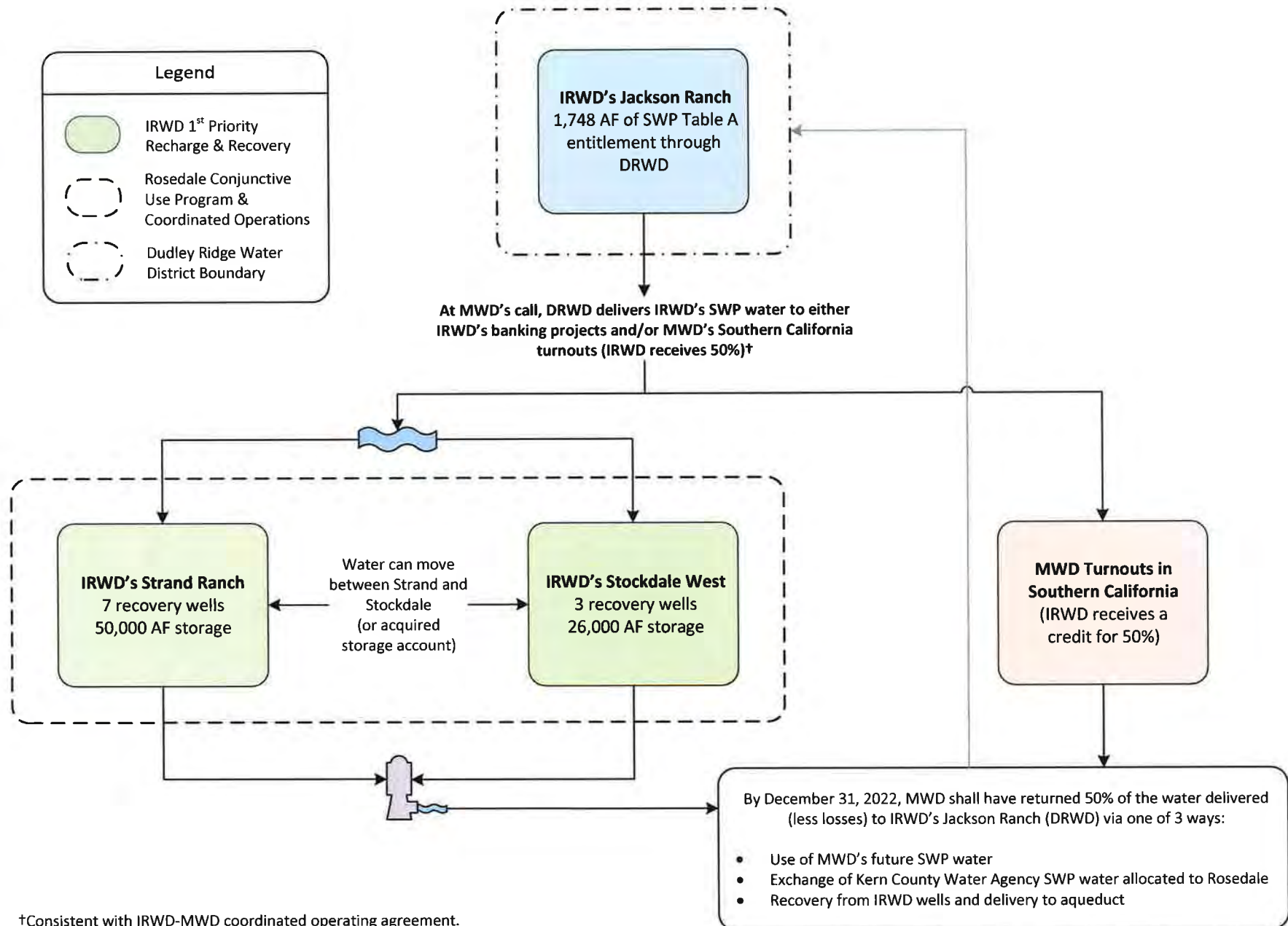
### Modified for 1-Year Recharge Program Only

| Year Following Recharge Event | Percent Transferred to IRWD | Percent Returned to BV During or Before Indicated Year |
|-------------------------------|-----------------------------|--------------------------------------------------------|
| 1                             | 50%                         | 50%                                                    |
| 2                             | 50%                         | 50%                                                    |
| 3                             | 50%                         | 50%                                                    |
| 4                             | 50%                         | 50%                                                    |
| 5                             | 50%                         | 50%                                                    |
| 6                             | 50%                         | 50%                                                    |
| 7                             | 75%                         | 25%                                                    |
| 8                             | 100%                        | 0%                                                     |
| 9                             | 100%                        | 0%                                                     |

# Exhibit "I"

## Dudley Ridge Water District (DRWD) Unbalanced Exchange Program

Up to 8,700 AF delivered from 12/16/2013 through 12/31/2017



†Consistent with IRWD-MWD coordinated operating agreement.

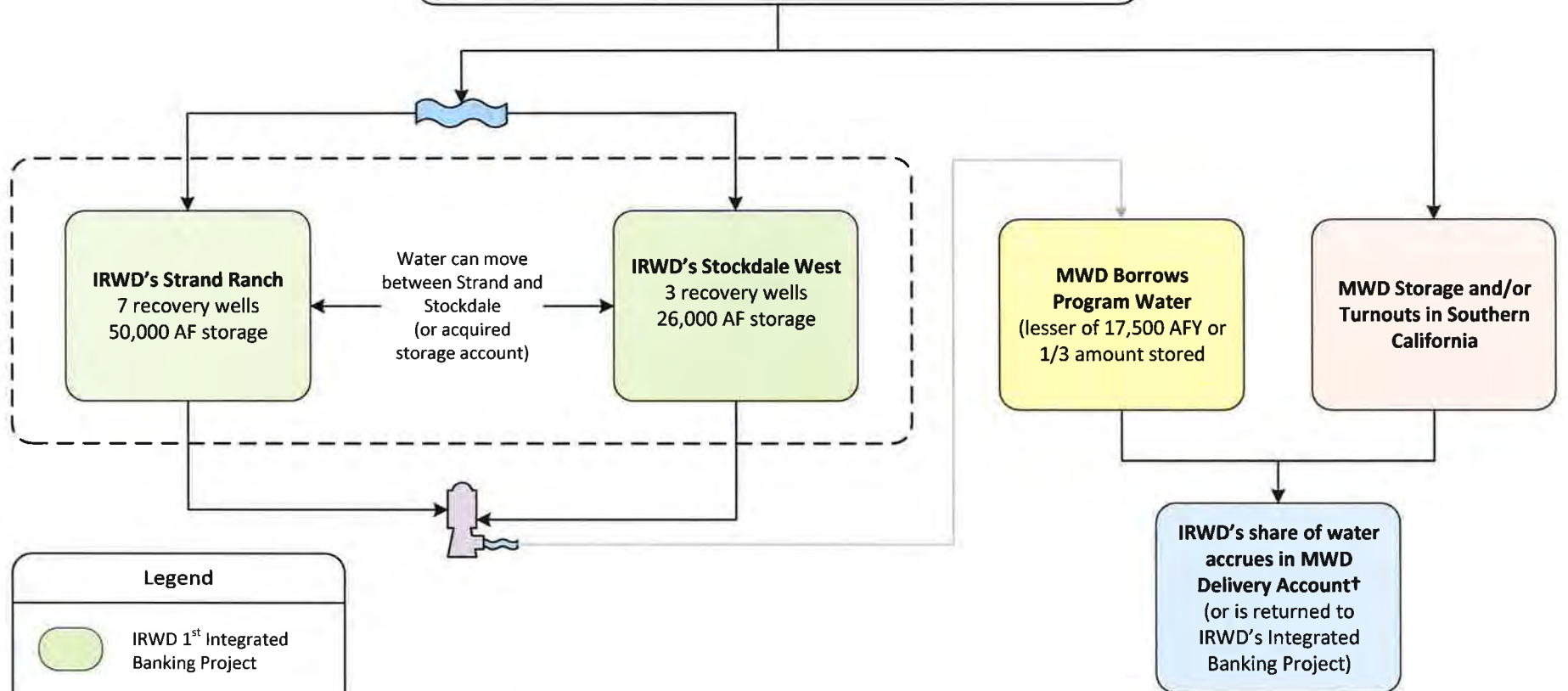
# Exhibit "J"

## Coordinated Operating, Water Storage, Exchange and Delivery Agreement Between MWD, MWDOC and IRWD Effective 5/1/2011 through 11/4/2035

With MWD's consent, IRWD secures SWP water (Program Water) through exchanges with IRWD Banking Partners for use as extraordinary supply under MWD Water Supply Allocation Plan

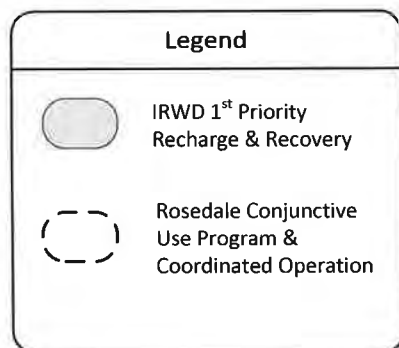
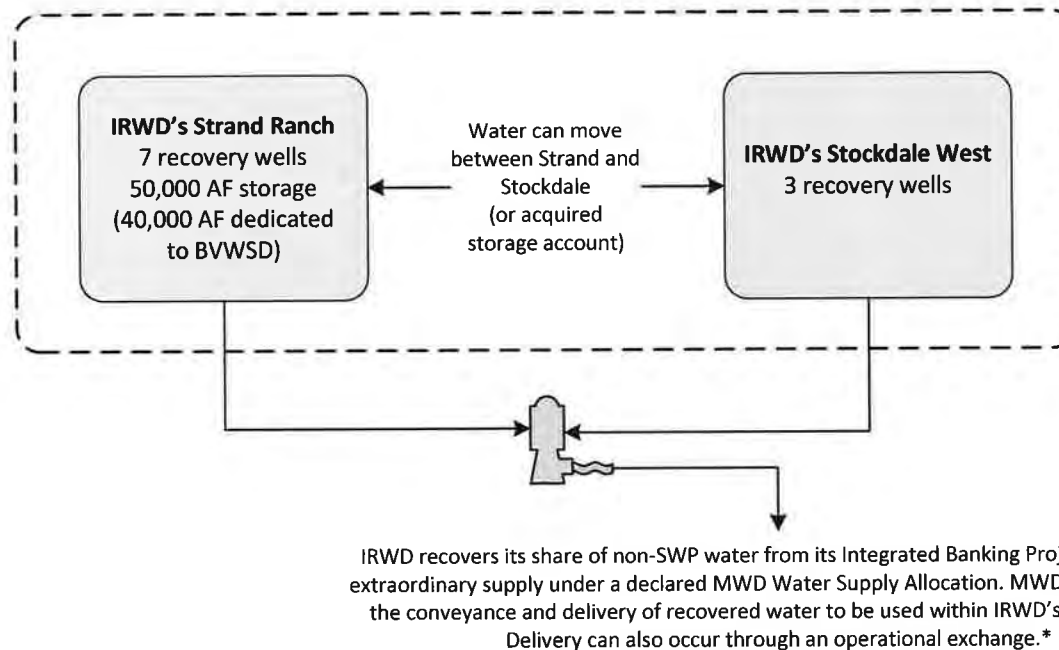
MWD has three options for the use and storage of Program Water:

- Storage of water in IRWD's Integrated Banking Project
- Delivery to Southern California for immediate use and/or storage in MWD system
- Borrow a portion of Program water, with accrual in MWD Delivery Account



- Under an MWD Allocation, when IRWD calls for water, IRWD must first recover Program Water from the Integrated Banking Project before receiving water from the MWD Delivery Account.
- MWDOC shall pass through extraordinary supply credits for IRWD's benefit.
- † IRWD's banking partner share of Program Water to be returned by MWD.

**Exhibit "K"**  
**Agreement for Conveyance of Water Between MWD, MWDOC, and IRWD (Wheeling Agreement)**  
Template for future agreements



\*The recovered water must be used within IRWD's service area. IRWD to pay MWD wheeling charges, including system access rate, water stewardship rate, and treatment surcharge (if applicable), for each acre foot of recovered water wheeled by MWD. IRWD will pay the actual costs of power incurred by MWD to convey recovered water in the California Aqueduct to IRWD delivery points.

April 19, 2018

Prepared by: R. Bennett/K. Welch

Submitted by: F. Sanchez/P. Weghorst

Approved by: Paul A. Cook 

## SUPPLY RELIABILITY PROGRAMS COMMITTEE

### STRAND RANCH 2018 INFILTRATION STUDY

#### SUMMARY:

In late 2017 and early 2018, Irvine Ranch Water District and Rosedale-Rio Bravo Water Storage District conducted a recharge pond infiltration study at IRWD's Strand Ranch Integrated Banking Project. The infiltration study was performed to evaluate the effectiveness of performing various land treatments to increase recharge rates. At the Committee meeting, staff will review prior studies and evaluations of Strand Ranch recharge rates and provide an overview of the 2018 Infiltration Study including findings and recommendations.

#### BACKGROUND:

Recharge rates on the Strand Ranch can vary based on existing geology along with a number of changing conditions. Staff has conducted several investigations to better understand the conditions that drive changes in these infiltration rates. The previous investigations are described in the following table:

| Year | Investigator                  | Description                                                                                          |
|------|-------------------------------|------------------------------------------------------------------------------------------------------|
| 2011 | Wildermuth Environmental Inc. | A basin reconnaissance study that evaluated the topsoil of the south basins on the Strand Ranch      |
| 2012 | Rosedale                      | Pond water elevation change measurements (pond drop) of the Strand and Stockdale West Ranch Projects |
| 2012 | IRWD                          | Identification of high recharge rate areas through orthophotograph interpretation                    |
| 2017 | Thomas Harder & Company       | Analysis of infiltration rates at the Strand Ranch during the period of January through June 2017    |

In response to declining infiltration rates that were observed in 2017, staff coordinated with Rosedale to conduct an investigation of the effect of various land treatments on infiltration rates using three recharge basins on the south side of the Strand Ranch. This new study, referred to as the 2018 Infiltration Study, occurred over the period from November 2017 to February 2018.

#### 2018 Infiltration Study Overview:

On November 1, 2017, Rosedale initiated the 2018 Infiltration Study by establishing baseline recharge rates on ponds 4, 5, and 6 of the Strand Ranch. The location of the three ponds is shown on Exhibit "A". The baseline recharge rates were obtained by terminating water

deliveries to the three ponds and conducting daily pond drop measurements of infiltration rates. The basins were then allowed to dry in advance of testing different land treatments for effectiveness at increasing infiltration rates. The land treatments tested on ponds 4, 5, and 6 are described in the following table:

| Pond No. | Land Treatment                                   |
|----------|--------------------------------------------------|
| 4        | Scraping the top three inches of soil            |
| 5        | Scraping and ripping the soil to about 30 inches |
| 6        | Pond allowed to dry without treatment            |

Following the completion of the land treatments, a new series of daily pond drop measurements were performed.

#### *Study Results:*

Staff reviewed the average change in infiltration rate associated with each land treatment using the measurements from both the baseline and post-treatment pond drop study. Based on data collected, the drying and scraping treatment that was applied to Pond 4 and the drying only method applied to Pond 6 had no positive impact on infiltration rates. Pond 5, which was dried, scraped, and ripped had a significantly lower infiltration rate following treatment than what was identified in the baseline pond drop measurements. The following table presents the results of the 2018 Infiltration Study.

| Strand Ranch Pond No. | Treatment            | Pre-Treatment Infiltration Rate (feet/day) | Post-Treatment Infiltration Rate (feet/day) | Change in Infiltration Rate (feet/day) |
|-----------------------|----------------------|--------------------------------------------|---------------------------------------------|----------------------------------------|
| 4                     | Scraping             | 0.33                                       | 0.30                                        | -0.03                                  |
| 5                     | Scraping and ripping | 0.25                                       | 0.14                                        | -0.11                                  |
| 6                     | No treatment         | 0.17                                       | 0.13                                        | -0.05                                  |

#### *Study Report:*

Staff compiled information from the 2018 Infiltration Study and compared the study results with those from the previous investigations identified above and developed findings. The findings from the 2018 Infiltration Study were then compared to the orthophotograph of the basins that was interpreted in 2012, which identified high recharge areas based on the condition of planted safflower. Since the land treatments that were applied in the 2018 study had no positive impact on infiltration rates, it is concluded in the report that the application of land treatments would not vary dependent on the condition of planted safflower or surface geology.

Staff prepared the 2018 Infiltration Study report which is included as Exhibit "B". The report provides details related to the findings and observations of the Strand Ranch recharge investigations. Based on the findings, the report provides recommendations related to future recharge pond maintenance activities at the Strand and Stockdale West Integrated Banking Projects.

*Findings and Recommendations:*

Infiltration at the Strand and Stockdale West recharge basins is a complex process that appears to be controlled by a number of variables including surface soils, subsurface geology, turbidity, and nutrient load in the source water. Of these, a highly variable subsurface geology appears to account for reductions in recharge rates as well as the uncertainties and inconsistencies with recharge rates. Comparisons of Strand Ranch infiltration rates to surrounding recharge areas, concludes that the Strand Ranch rates are similar to and not unusual for the area. Based on the information compiled in the 2018 Infiltration Study report, staff recommends the following:

- Continue to collect, analyze and monitor recharge rates at the Strand and Stockdale West properties and other water banking projects surrounding the properties to develop a better understanding of spatial and temporal variations in infiltration rates;
- Schedule pond drop measurements at the end of select recharge events to establish a long-term record of infiltration over time at the Strand and Stockdale West properties;
- Support Rosedale's efforts to periodically plant safflower or other crops that loosen the soil and control tumble weeds;
- Avoid land treatments such as disking and/or ripping that result in fine materials settling deeper into the soil profile;
- Scrape fine materials from the bottom of selected ponds following unusual events that clearly seal the bottoms of the ponds; and
- Monitor for research that is conducted by others related to increasing recharge rates at water banking projects.

At the Committee meeting, staff will review the prior evaluations and studies of Strand Ranch recharge rates and provide an overview of the 2018 Infiltration Study including findings and recommendations.

FISCAL IMPACTS:

None.

ENVIRONMENTAL COMPLIANCE:

Not applicable.

RECOMMENDATION:

Receive and file.

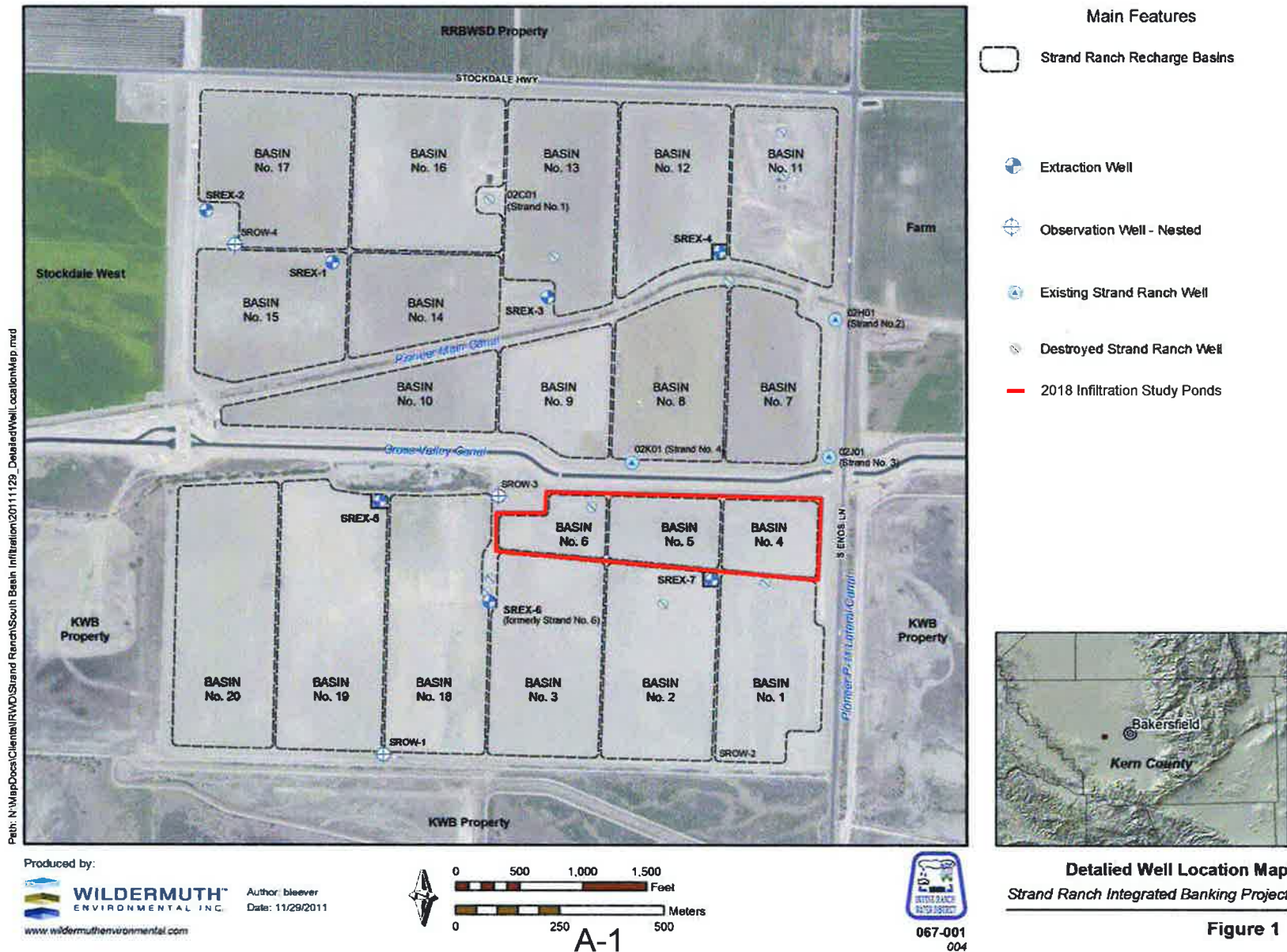
LIST OF EXHIBITS:

Exhibit "A" – Location of Recharge Basins Used In 2018 Infiltration Study

Exhibit "B" – Strand Ranch 2018 Infiltration Study – Final Draft

# Exhibit "A"

## Location of Recharge Basins used in 2018 Infiltration Study



# EXHIBIT "B"

## DRAFT



### Strand Ranch Infiltration Study

March, 2018



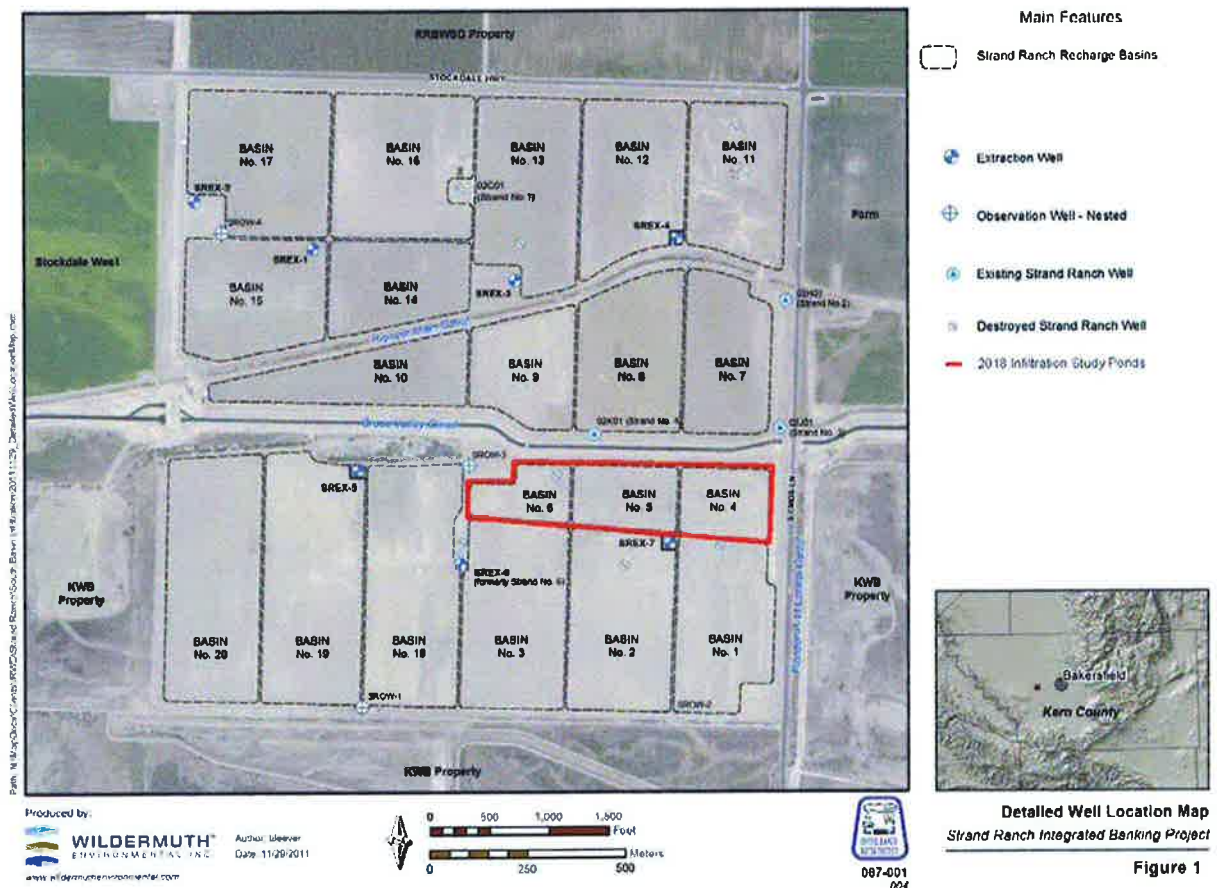
## **Table of Contents**

1. Introduction
  - 1.1. Schedule and Cost of Infiltration Study
2. 2018 Infiltration Study Results
3. Prior Evaluations of Strand Ranch Infiltration Rates
  - 3.1. October 2011 South Basin Reconnaissance and Remediation
  - 3.2. January 2012 Pond Drop Study
  - 3.3. August 2012 Recharge Area Mapping
  - 3.4. July 2017 Evaluation of Recharge Rates
4. Comparison of 2018 Infiltration Study to Prior Evaluations
5. Summary
6. Recommendations

## 1.0 Introduction

In late 2017 and early 2018, Irvine Ranch Water District (IRWD) and Rosedale-Rio Bravo Water Storage District (Rosedale) conducted the Strand Ranch Infiltration Study (2018 Infiltration Study). The 2018 Infiltration Study was performed to test various land treatments on selected recharge basins to see the effect on recharge rates. On November 1, 2017, Rosedale initiated the infiltration study by establishing baseline recharge rates on ponds 4, 5 and 6 of the Strand Ranch. The location of the three ponds included in the study is shown on Figure 1. Rosedale terminated water deliveries to these ponds and conducted pond drop measurements of the percolation rates. The basins were then allowed to dry in preparation for testing different land treatment options. The land treatment options included scraping the top 3 inches of soil from pond 4, scraping and ripping the soil to about 30 inches at pond 5 and performing no land treatment at pond 6.

**Figure 1**  
2018 Infiltration Study Location



## 1.1 Schedule and Cost of Infiltration Study

The entire infiltration study was completed over about a 3 ½-month period. The post-treatment pond drop measurements occurred approximately 4 weeks after the ponds were refilled. This delay had the benefit of providing an estimate of how a land treatment activity may influence long term, as opposed to immediate, infiltration rates. The total cost of the infiltration study was approximately \$25,800; \$3,700 for Rosedale's staff resources and \$22,140 for land treatments. The cost to mobilize and scrape was approximately \$5,500/acre while the cost to rip was approximately \$3,100/acre. Tables 1 and 2 provide details of the activities and costs associated with the 2018 Infiltration Study.

**Table 1**  
**2018 Strand Ranch Infiltration Study Schedule**

| Step | Week Completed | Item                                                                                                        |
|------|----------------|-------------------------------------------------------------------------------------------------------------|
| 1    | 11/1/17        | Pre-treatment pond drop measurements                                                                        |
| 2    | 11/28/17       | Ponds were dried                                                                                            |
| 3    | 12/12/17       | Land treatment complete. Pond 4 was scraped and ripped, Pond 5 was scraped and Pond 6 had no land treatment |
| 4    | 1/08/18        | Ponds refilled                                                                                              |
| 5    | 2/11/18        | Post-treatment pond drop measurements                                                                       |
| 6    | 2/16/18        | Results analyzed and reported                                                                               |

**Table 2**  
**2018 Strand Ranch Infiltration Study Cost**

| Item | Description                | Labor (\$) | Other (\$) | Total (\$) |
|------|----------------------------|------------|------------|------------|
| 1    | Pond 4 – Dry and scrape    |            | \$5,500    | \$5,500    |
| 2    | Pond 5 – Dry, scrape & rip |            | \$8,600    | \$8,600    |
| 3    | Pond 6 – Dry only          |            | \$0        | \$0        |
| 4    | Dust Control               |            | \$4,000    | \$4,000    |
| 5    | Rosedale staff             | \$2,100    |            | \$2,100    |
| 6    | Rosedale supervisor        | \$1,600    |            | \$1,600    |
| 7    | Miscellaneous (20%)        |            | \$4,040    | \$4,040    |
|      | Total                      | \$3,700    | \$22,140   | \$25,840   |

## 2.0 2018 Infiltration Study Results

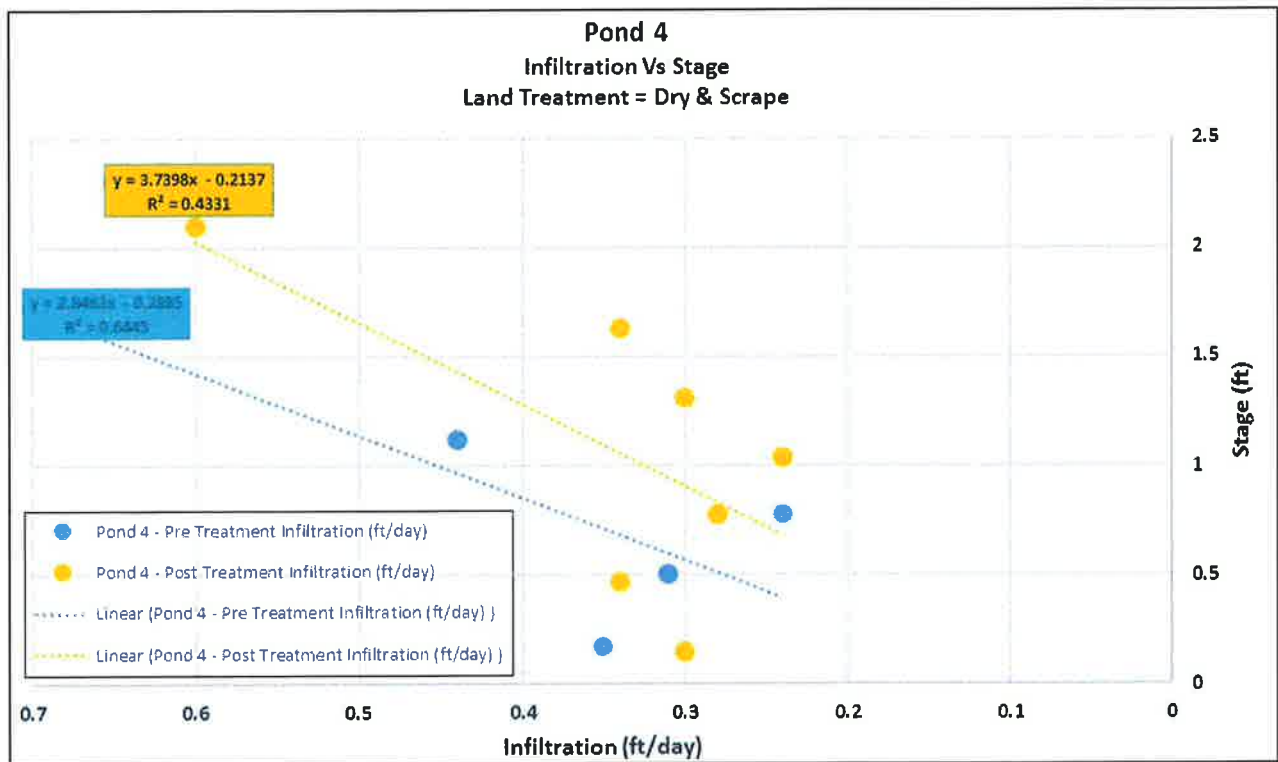
Table 3 provides a summary of the average change in infiltration rate associated with each land treatment. As shown, drying and scraping Pond 4 and drying Pond 6 had no significant impact on recharge rates after considering the uncertainty associated with field measurements. Pond 5 has a significantly lower infiltration rate after being both scraped and ripped.

**Table 3**  
**2018 Infiltration Study Results**

| Pond   | Treatment           | Pre Treatment Rate (ft/day) | Post Treatment Rate (ft/day) | Change Post - Pre Treatment (ft/day) |
|--------|---------------------|-----------------------------|------------------------------|--------------------------------------|
| Pond 4 | Dry & scrape        | 0.33                        | 0.30                         | -0.03                                |
| Pond 5 | Dry, scrape and rip | 0.25                        | 0.14                         | -0.11                                |
| Pond 6 | Dry only            | 0.17                        | 0.13                         | -0.05                                |

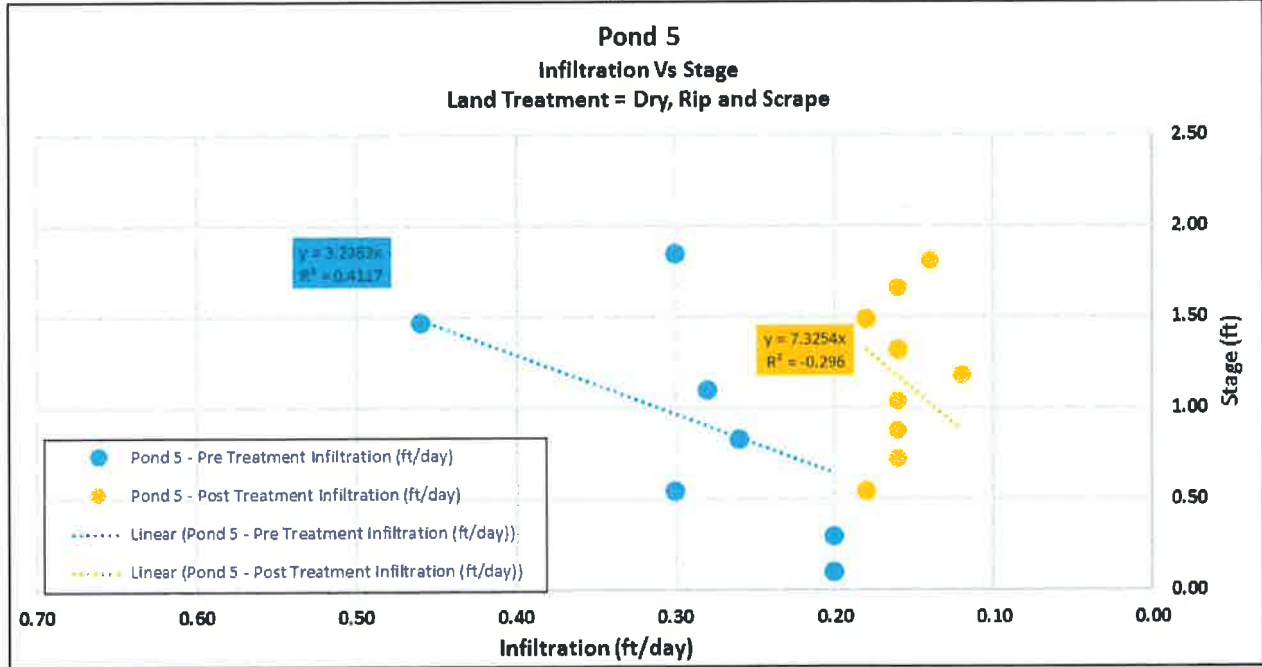
Based on data collected from the 2018 Infiltration Study, Figures 2, 3 and 4 show how infiltration rates changed with the stage (water elevation) in each pond with different land use treatments. In each figure, the data points represent a daily measurement of stage and infiltration rate. Values in blue represent pre-treatment data while the values in brown represent post-treatment data.

**Figure 2**



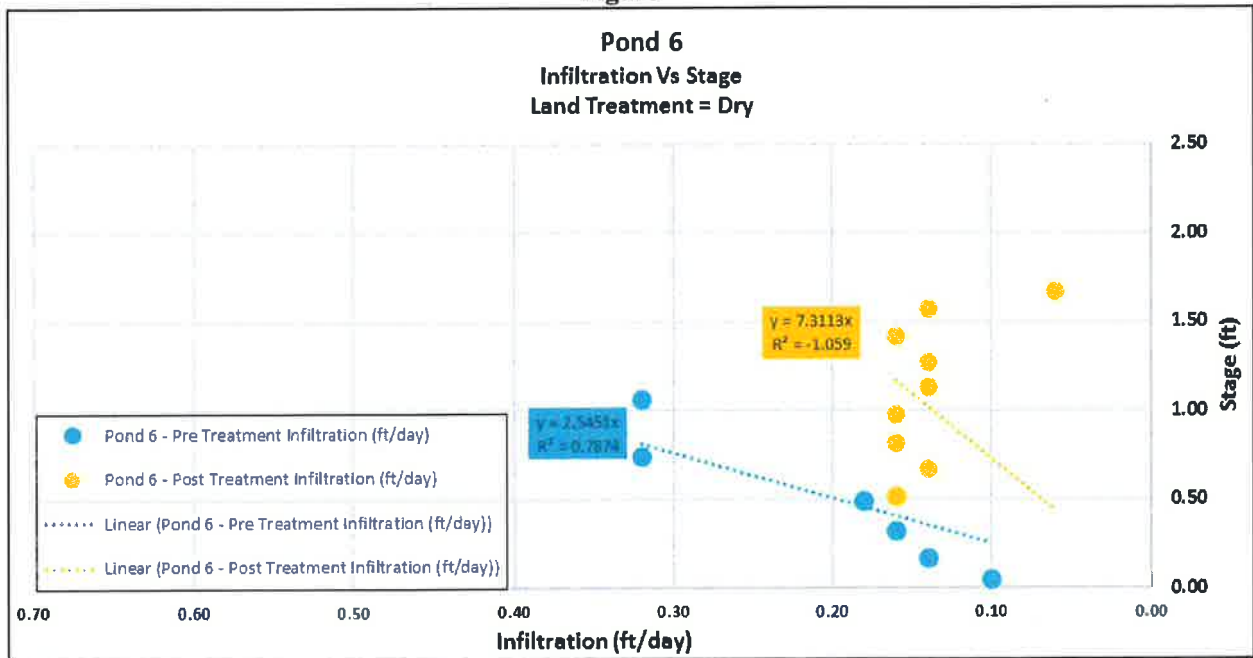
As shown in Figure 2, Pond 4 was dried and scraped which appears to have a slight negative impact on infiltration rates over a range of pond stages. Although there is significant scatter in the observations there is a general trend for recharge to decrease with stage.

**Figure 3**



As shown in Figure 3, Pond 5 was dried, scraped and ripped and the ripping activity appears to impair infiltration rates particularly at higher stages. The post treatment infiltration rates appear to be significantly less than the pre-treatment infiltration rates.

**Figure 4**



Pond 6, which was only allowed to dry out, shows no significant improvement on infiltration rates.

### **3.0 Prior Evaluation of Strand Ranch Infiltration Rates**

This section compares the results of the 2018 Infiltration Study to prior evaluations of recharge rates on Strand Ranch. The prior evaluations include a Basin Reconnaissance performed by Wildermuth Environmental, Inc. (WEI) in October 2011, a Pond Drop Study performed by Rosedale in January 2012, recharge area mapping by staff in August 2012, and an Evaluation of Recharge Rates by Thomas Harder & Company (TH&C) in July 2017.

#### **3.1 October 2011 South Basin Reconnaissance and Remediation**

In September 2011, WEI conducted a field reconnaissance of the south Strand Ranch basins to determine if the observed infiltration rate declines could be attributed to clogging of the basins, and to determine the nature of the clogging material. WEI observed a fine-grained sediment and/or algae clogging layer was predominately present at the bottom of each basin, which attributed to the decline in recharge rates. WEI recommended a motor grader be used to move the clogging layer overlying the basin bottoms into windrows and then removed by a scraper and disposed. WEI concluded that compaction of the basin soils likely occurred when wheeled and tracked heavy equipment was used to construct the basins.

#### **3.2 January 2012 Pond Drop Study**

During recharge events in 2011, IRWD and Rosedale observed reduced recharge rates particularly in the Strand Ranch south basins. In January 2012, Rosedale performed pond drop measurements on the Strand Ranch and Stockdale West basins.

Table 4 shows the staff gauge readings from daily observations at all ponds basins over a 10-day period. Ponds 4, 5, and 6, which were part of the 2018 Infiltration Study, showed relatively high recharge rates ranging from 0.29 to 0.31 feet/day (highlighted in brown). Other ponds located both north and south are highly variable with rates ranging from 0.02 feet/day to 0.31 feet/day.

Table 4

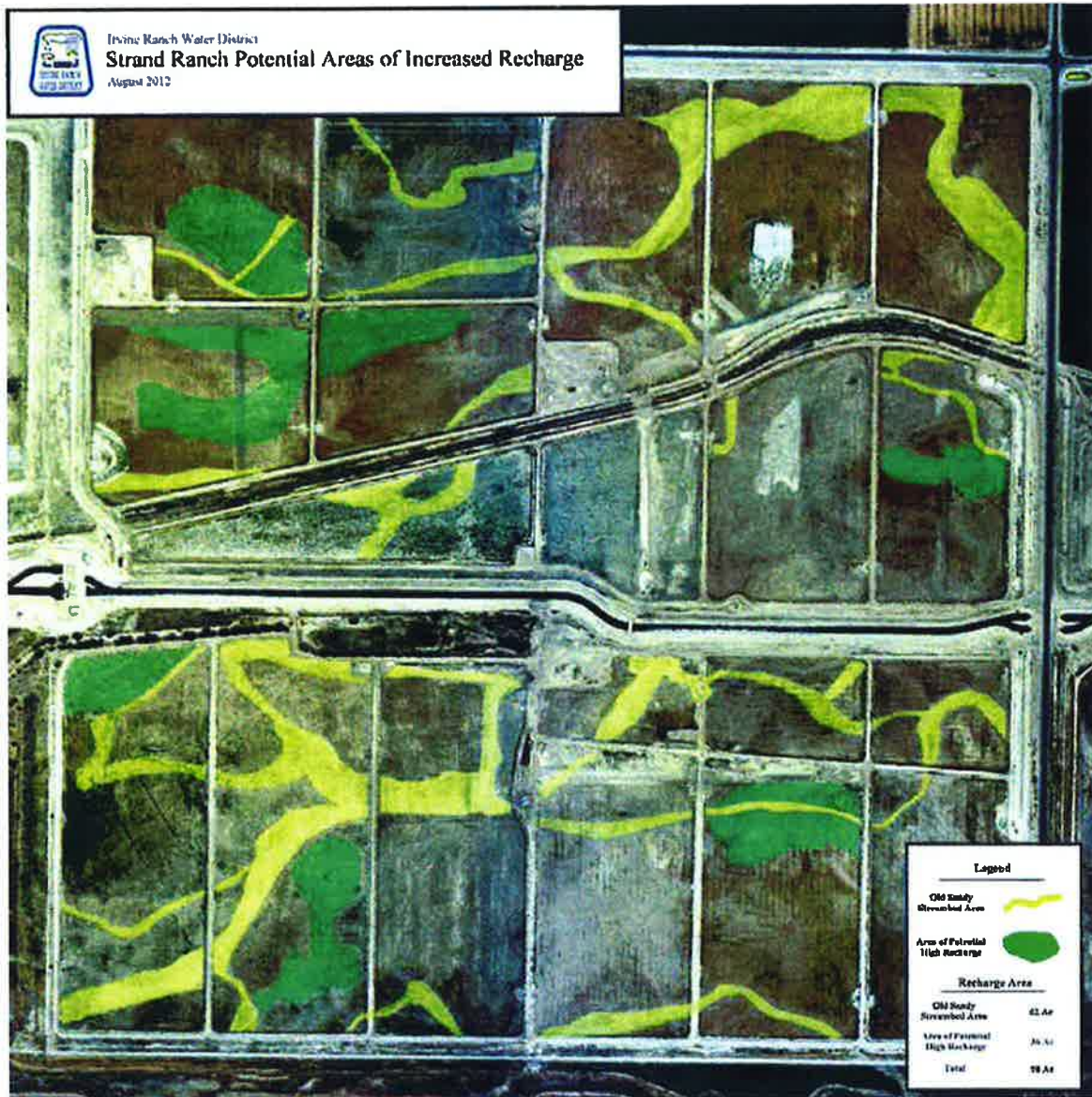
## Staff Gauge Readings for January 2012 Pond Drop Measurements

| Area                                                                                                                                    | Basin Number | Acres | Jan-5<br>(ft)  | Jan-6<br>(ft) | Jan-7<br>(ft) | Jan-8<br>(ft) | Jan-9<br>(ft) | Jan-10<br>(ft) | Jan-11<br>(ft) | Jan-12<br>(ft) | Jan-13<br>(ft) | Jan-14<br>(ft) | Infiltration<br>Rate <sup>1</sup><br>(ft/day) |
|-----------------------------------------------------------------------------------------------------------------------------------------|--------------|-------|----------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|-----------------------------------------------|
| South Strand                                                                                                                            | 1            | 25.46 | 3.00           | 2.80          | 2.66          | 2.56          | 2.42          | 2.30           | 2.20           | 2.06           | 1.92           | 1.78           | 0.14                                          |
| South Strand                                                                                                                            | 2            | 31.44 | - <sup>2</sup> | 2.10          | 2.00          | 1.96          | 1.86          | 1.80           | 1.70           | 1.60           | 1.50           | 1.40           | 0.09                                          |
| South Strand                                                                                                                            | 3            | 32.21 | -              | 1.68          | 1.58          | 1.52          | 1.42          | 1.32           | 1.24           | 1.14           | 1.06           | 0.96           | 0.09                                          |
| South Strand                                                                                                                            | 4            | 9.94  | 3.08           | 2.48          | 2.00          | 1.66          | 1.30          | 0.96           | 0.64           | 0.51           | 0.38           | 0.30           | 0.31                                          |
| South Strand                                                                                                                            | 5            | 10.56 | 2.38           | 2.04          | 1.66          | 1.40          | 1.12          | 0.84           | 0.58           | 0.32           | 0.00           | -              | 0.30                                          |
| South Strand                                                                                                                            | 6            | 7.54  | 2.30           | 1.96          | 1.62          | 1.34          | 1.06          | 0.78           | 0.50           | 0.28           | 0.00           | -              | 0.29                                          |
| South Strand                                                                                                                            | 18           | 37.00 | 1.72           | 1.68          | 1.60          | 1.50          | 1.42          | 1.34           | 1.24           | 1.16           | 1.06           | 0.96           | 0.08                                          |
| South Strand                                                                                                                            | 19           | 40.00 | 1.40           | 1.34          | 1.24          | 1.16          | 1.10          | 1.00           | 0.96           | 0.84           | 0.74           | 0.64           | 0.08                                          |
| South Strand                                                                                                                            | 20           | 36.00 | 0.32           | 0.22          | 0.12          | 0.00          | -             | -              | -              | -              | -              | -              | 0.11                                          |
| North Strand                                                                                                                            | 7            | 21.35 | 2.78           | 2.46          | 2.20          | 2.04          | 1.90          | 1.80           | 1.70           | 1.60           | 1.52           | 1.44           | 0.15                                          |
| North Strand                                                                                                                            | 8            | 25.44 | 2.30           | 2.24          | 2.16          | 2.10          | 2.04          | 1.96           | 1.90           | 1.84           | 1.76           | 1.68           | 0.07                                          |
| North Strand                                                                                                                            | 9            | 17.66 | 2.26           | 2.22          | 2.22          | 2.18          | 2.14          | 2.12           | 2.12           | 2.12           | 2.12           | 2.10           | 0.02                                          |
| North Strand                                                                                                                            | 10           | 19.80 | 1.84           | 1.80          | 1.76          | 1.70          | 1.66          | 1.60           | 1.56           | 1.52           | 1.46           | 1.40           | 0.05                                          |
| North Strand                                                                                                                            | 11           | 24.29 | 2.50           | 2.10          | 1.98          | 1.90          | 1.80          | 1.70           | 1.60           | 1.48           | 1.36           | 1.12           | 0.15                                          |
| North Strand                                                                                                                            | 12           | 26.56 | 2.52           | 2.10          | 2.00          | 1.96          | 1.90          | 1.74           | 1.70           | 1.73           | 1.76           | 1.62           | 0.10                                          |
| North Strand                                                                                                                            | 13           | 30.60 | 2.44           | 2.08          | 1.84          | 1.76          | 1.72          | 1.66           | 1.64           | 1.62           | 1.56           | 1.56           | 0.10                                          |
| North Strand                                                                                                                            | 14           | 19.16 | 2.58           | 2.36          | 2.16          | 2.04          | 1.84          | 1.64           | 1.46           | 1.26           | 1.10           | 0.96           | 0.18                                          |
| North Strand                                                                                                                            | 15           | 25.89 | 2.26           | 2.08          | 1.98          | 1.72          | 1.56          | 1.36           | 1.14           | 0.98           | 0.80           | 0.62           | 0.18                                          |
| North Strand                                                                                                                            | 16           | 32.05 | -              | -             | 2.04          | 1.94          | 1.86          | 1.80           | 1.73           | 1.66           | 1.64           | 1.60           | 0.06                                          |
| North Strand                                                                                                                            | 17           | 30.88 | -              | -             | 2.40          | 2.30          | 2.20          | 2.02           | 1.88           | 1.74           | 1.60           | 1.42           | 0.14                                          |
| Stockdale West                                                                                                                          | 1            | 57.80 | 2.58           | 2.50          | 2.26          | 2.12          | 1.98          | 1.80           | 1.66           | 1.50           | 1.34           | 1.18           | 0.16                                          |
| Stockdale West                                                                                                                          | 2            | 69.00 | 2.70           | 2.60          | 2.40          | 2.24          | 2.02          | 1.86           | 1.68           | 1.50           | 1.30           | 1.14           | 0.17                                          |
| Stockdale West                                                                                                                          | 3            | 67.10 | 2.46           | 2.40          | 2.24          | 2.16          | 2.04          | 1.94           | 1.82           | 1.70           | 1.60           | 1.44           | 0.11                                          |
| Stockdale West                                                                                                                          | 4            | 56.50 | 1.86           | 1.66          | 1.50          | 1.32          | 1.06          | 1.00           | 0.84           | 0.68           | 0.54           | 0.40           | 0.16                                          |
| <b>Notes:</b>                                                                                                                           |              |       |                |               |               |               |               |                |                |                |                |                |                                               |
| <sup>1</sup> Infiltration rate is equal to the first measurement minus the last measurement, divided by the number of days.             |              |       |                |               |               |               |               |                |                |                |                |                |                                               |
| <sup>2</sup> Indicates measurements not used in the analysis.                                                                           |              |       |                |               |               |               |               |                |                |                |                |                |                                               |
| Values in red were estimated by interpolation.                                                                                          |              |       |                |               |               |               |               |                |                |                |                |                |                                               |
| Ponds 4, 5 and 6 (shown in brown) were part of 2018 land treatment study.                                                               |              |       |                |               |               |               |               |                |                |                |                |                |                                               |
| Ponds 2, 19, 20, 14, 15 and 17 (shown in blue) were mapped as areas of high recharge based on an analysis of vegetative growth in 2012. |              |       |                |               |               |               |               |                |                |                |                |                |                                               |

## 3.3 August 2012 Recharge Area Mapping

In October 2012, staff reviewed color orthophotographs of Strand and Stockdale West recharge basins from August 2012, which identified areas of high recharge potential based on the condition of recently planted safflower. The orange safflower growth is lowest in the sandy areas that did not retain moisture. To interpret the orthophotographs, staff digitized the locations of the prominent sandy areas that depict lower safflower growth that were estimated to be higher recharge areas. Figure 5 shows the aerial photo of Strand Ranch from 2012 with the colored areas showing potentially increased recharge.

Figure 5



As presented, Ponds 4, 5 and 6 have a similar density of old streambed materials whose sand should provide a relatively high recharge potential. Therefore, it is reasonable to assume that the results of the analysis of the three land use measures in the 2018 Infiltration Study were not biased by the types of soils found at these pond locations.

Staff compared the colored recharge areas from Figure 5 with the 2012 pond drop measurement results presented in Table 4. From Table 4, the ponds with a brown highlight were part of the 2018 study and had relatively high recharge rates ranging from 0.29 to 0.31 feet/day. The ponds with a blue highlight, which were identified as having a high recharge potential by the aerial photo mapping

were not part of the 2018 Infiltration Study. As shown, ponds located in the south (ponds 2, 19 and 20) had relatively low infiltration estimates that ranged from 0.08 to 0.11 feet/day, while those in the north (14, 15 and 17) had relatively high infiltration estimates that ranged from 0.14 to 0.18 feet/day. Based on these inconsistent results, it is reasonable to conclude that recharge is constrained by other variables, in addition to the surface materials identified in the aerial photo investigation.

### 3.4 July 2017 Evaluation of Recharge Rates

In July 2017, IRWD contracted with TH&C to perform an evaluation of recharge rates from January to June 2017 on the Strand Ranch. The analysis was performed using daily stage measurements with total inflow measured at the inlets to the north and south basins at Strand. TH&C recommended no rehabilitation of the Strand basins until the end of the recharge cycle or when water deliveries are terminated. TH&C recommended the rehabilitation by allowing the basin bottoms to dry and removing the upper fine-grained silt layer (only a few inches) using a scraper. It was not recommended to plow or furrow the basin bottoms as this may settle fines deeper into the shallow subsurface making it difficult to remove.

### 4.0 Comparison of 2018 Infiltration Study with Prior Evaluations:

Staff compiled information from the 2018 Infiltration Study for comparison with the prior recharge evaluations performed in 2012 and 2017. Table 5 provides a summary of the pre-treatment 2018 infiltration estimates along with the data observed in 2012 by Rosedale and in early 2017 by TH&C. The 2012 data was collected by pond, while the 2017 data was aggregated into northern and southern areas. After considering the uncertainty associated with the field measurements, infiltration in ponds 4 and 5 appears to be relatively consistent over time while pond 6 appears to have decreased.

**Table 5**  
Infiltration Rate Study Comparisons

| Pond                                                                               | 2012<br>Infiltration<br>by Pond<br>(ft/day) | 2017<br>Infiltration<br>for South<br>(ft/day) <sup>(1)</sup> | 2018 - Pre<br>Treatment<br>Infiltration )<br>(ft/day) |
|------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------|
| Pond 4                                                                             | 0.31                                        | 0.32                                                         | 0.33                                                  |
| Pond 5                                                                             | 0.30                                        | 0.32                                                         | 0.25                                                  |
| Pond 6                                                                             | 0.29                                        | 0.32                                                         | 0.17                                                  |
| (1) 2017 study results represent an average for south ponds; not ponds 4, 5 and 6. |                                             |                                                              |                                                       |

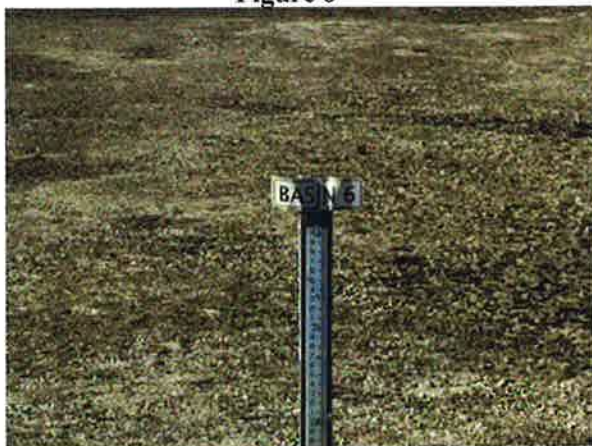
### 5.0 Summary

A summary of the 2018 Infiltration Study findings and observations is as follows:

1. Land use treatment ranging from drying the ponds, to scraping the top few inches of soil, to scraping and ripping the soil do not appear to significantly increase infiltration rates. Ripping the soil appears to have a negative impact on infiltration rates.

2. The recharge evaluations conducted at the Strand Ranch in 2012, 2017 and 2018 provide relatively consistent results for Ponds 4 and 5 after considering the uncertainty associated with collecting field data. Pond 6, which was only dried in the 2018 Infiltration Study, had a significantly lower infiltration rate in 2018 than was observed in 2012 and 2017.
3. The aerial interpretation of vegetation at the ponds performed in 2012 provides valuable information on which ponds may be expected to have higher infiltration rates than others. When compared with the 2012 pond drop measurements, the inconsistent results indicate that surface soils may be a good indicator of infiltration rates, but there are other variables that can control infiltration.
4. Since the land treatments that were applied in the 2018 study had no positive impact on infiltration rates, it is concluded that the application of land treatments would not vary dependent on the condition of planted safflower or surface geology.
5. Conducting pond drop measurements with the existing infrastructure at Strand and Stockdale West should be considered approximate. Inaccuracies in water level measurements can result from reading stage data to the nearest hundredth of a foot (Figure 6) and using un-tarped, stacked boards at each pond inlet (Figure 7) that can result in inaccurate measurements. Improvements to the current measurement systems in the basins is not expected to be cost effective.

**Figure 6**



**Figure 7**



6. Infiltration at the Strand and Stockdale West facilities is a complex process that can be impacted by a number of variables including but not limited to: surface soils, subsurface geology, turbidity of recharged water and the nutrient load of the recharged water. Of these, a highly variable subsurface geology appears to account for sometimes-conflicting data. Figure 8 is a geologic cross section of the Strand Ranch lithology from two production wells (SRES-

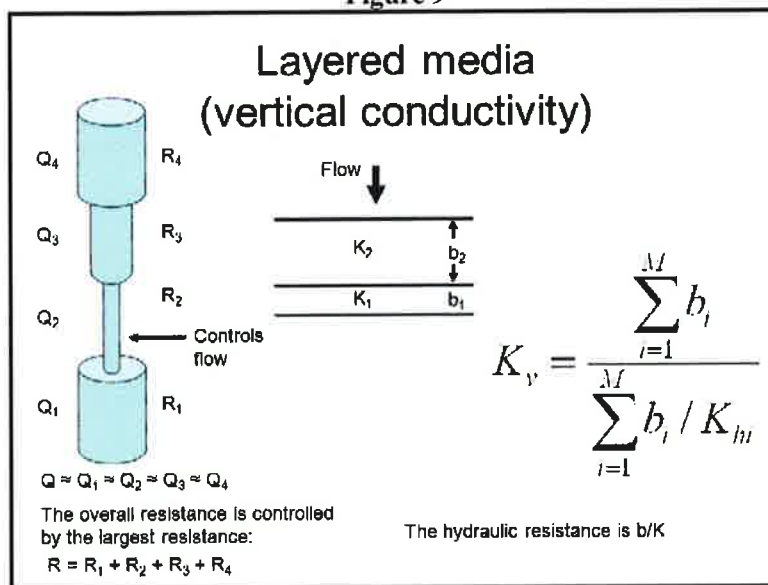
5 and SREX-7) and one observation well (SROW-3) drilled in 2010. As shown, there are numerous references to silt and/or clay that have relatively low infiltration rates.

Figure 8

| Strand Ranch Lithology near Ponds 4, 5 and 6 |                                                                                 |        |                                                                                         |        |                                                                      |
|----------------------------------------------|---------------------------------------------------------------------------------|--------|-----------------------------------------------------------------------------------------|--------|----------------------------------------------------------------------|
| SREX-5                                       |                                                                                 | SROW-3 |                                                                                         | SREX-7 |                                                                      |
| Depth                                        | Lithology                                                                       | Depth  | Lithology                                                                               | Depth  | Lithology                                                            |
| 10                                           | Silt (yellow brown)                                                             | 10     | Silty sand and sandy silts (olive brown)                                                | 10     | Silt (dark yellow brown)                                             |
| 20                                           | Sandy silt & silty sand (olive brown)                                           | 20     |                                                                                         | 20     | Silt with sand (dark yellow-brown)                                   |
| 30                                           | Fine to coarse sand (olive brown)                                               | 30     |                                                                                         | 30     |                                                                      |
| 40                                           |                                                                                 | 40     |                                                                                         | 40     | Clay (yellow brown)                                                  |
| 50                                           | Fine to medium sand (light brown)                                               | 50     | Fine to medium grain sands with thin silt and clay interbeds (brown to yellowish-brown) | 50     | Fine Sand (olive brown) with thick (55 ft) intervals of clayey sand. |
| 60                                           |                                                                                 | 60     |                                                                                         | 60     |                                                                      |
| 70                                           | Silty sand and poorly graded fine to medium sand (light olive brown to greyish) | 70     |                                                                                         | 70     |                                                                      |
| 80                                           |                                                                                 | 80     |                                                                                         | 80     |                                                                      |
| 90                                           |                                                                                 | 90     |                                                                                         | 90     |                                                                      |
| 100                                          |                                                                                 | 100    |                                                                                         | 100    |                                                                      |

7. Depending on the vertical and lateral persistence of geologic materials with low infiltration rates, pond infiltration can vary greatly from one location to the next and one pond to the next. As shown in Figure 9, vertical infiltration is constrained by the zone with the lowest conductance (highest resistance).

Figure 9



## **6.0 Recommendations**

Based on the information compiled on the Strand Ranch recharge rates, staff recommends the following:

- Continue to collect, analyze and monitor recharge rates at the Strand and Stockdale West properties and other water banking projects surrounding the properties to develop a better understanding of spatial and temporal variations in infiltration rates;
- Schedule pond drop measurements at the end of select recharge events to establish a long-term record of infiltration over time at the Strand and Stockdale West properties;
- Support Rosedale's efforts to periodically plant safflower or other crops that loosen the soil and control tumble weeds;
- Avoid land treatments such as disking and/or ripping that result in fine materials being settled deeper into the soil profile;
- Scrape fine materials from the bottom of selected ponds following unusual events that clearly seal the bottoms of the ponds; and
- Monitor for research that is conducted by others related to increasing recharge rates at water banking projects.