# ANALYSIS IN SUPPORT OF GREEN AND GRAY STORMWATER INFRASTRUCTURE DECISION-MAKING

**Parmdeep "Eric" Uppal, OWP Graduate Research Fellow**

*Department of Civil Engineering, Sacramento State*

**Water Resources Control Engineer,** *California State Water Resources Control Board*

**Brian Currier, Senior Research Engineer**

*Office of Water Programs, Sacramento State*

**Dr. John Johnston, Professor**

*Dept of Civil Engineering, Sacramento State*

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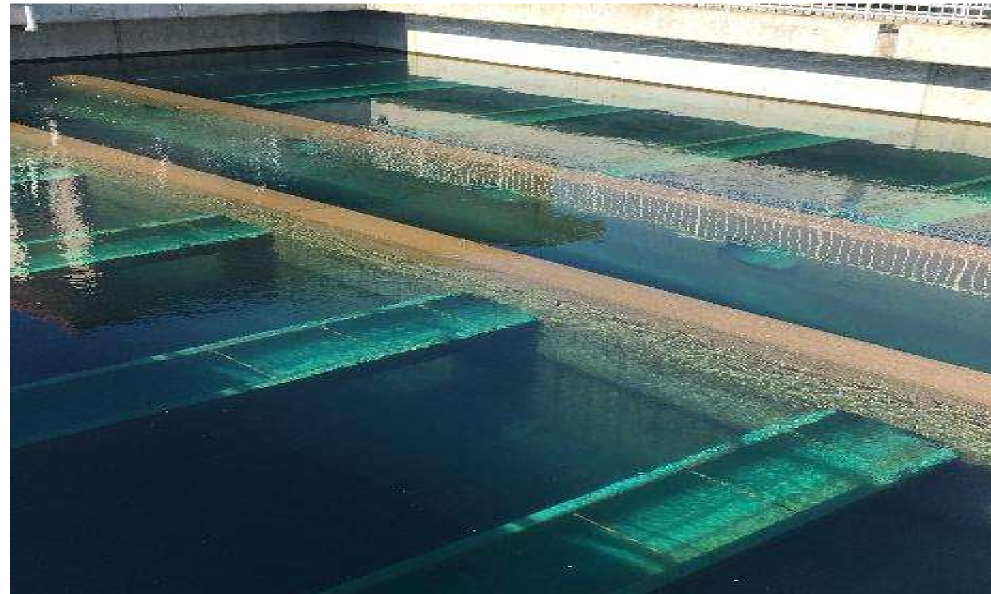
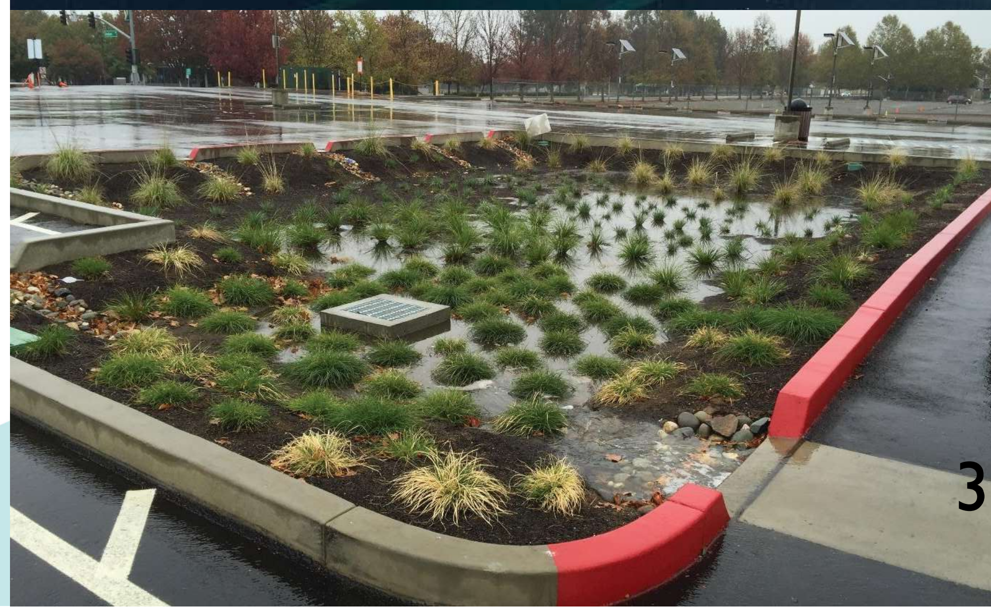
WATER PROGRAMS
Sacramento State

# GOAL:
# SUSTAINABLE STORMWATER MANAGEMENT BY EVALUATING ALTERNATIVES

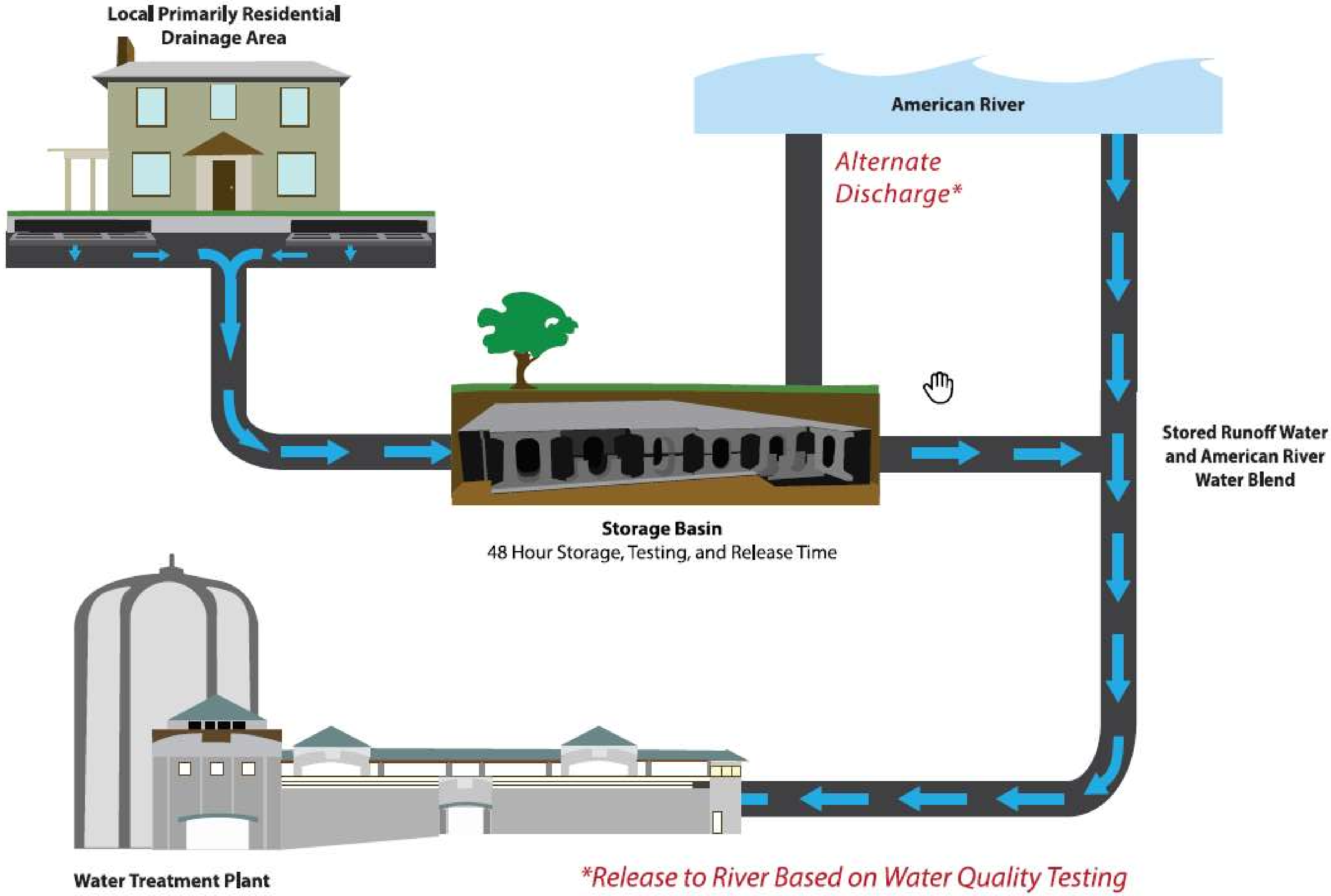
# STUDY OBJECTIVES

- Explore technical feasibility of diversion of urban runoff to a drinking water treatment facility
- Estimate diversion cost
- Compare to green stormwater infrastructure (GSI) cost





# HYPOTHETICAL CASE STUDY


Local Primarily Residential Drainage Area
American River
Alternate Discharge*
Stored Runoff Water and American River Water Blend
Storage Basin
48 Hour Storage, Testing, and Release Time
Water Treatment Plant
*Release to River Based on Water Quality Testing

# Untreated Runoff: We assumed an upper limit to conservatively check treatment feasibility.

| Constituent | Unit | Sacramento* | NSQD** | Selected Upper Limit |
|---|---|---|---|---|
| **Cu** | µg/L | 14 | 16 | 2,100 |
| **E. Coli** | MPN/100 mL | 13,000 | 1,100 | 270,000 |
| **Fecal Coliform** | MPN/100 mL | 22,000 | 11,210 | 270,000 |
| **Hg** | µg/L | 0.04 | 0.2 | 0.06 |
| **Pb** | µg/L | 6 | 16 | **51** |
| **Nitrate/Nitrate** | mg/L | 0.7 | 0.6 | 2.26 |
| **TOC** | mg/L | 20 | -- | 36 |
| **Turbidity** | NTU | 36 | -- | 160 |

*Strong Ranch Slough, Median

**NSQD: National Stormwater Quality Database, Mixed Residential, Median

# FEASIBILITY: IN-PLANT TREATMENT AND MCLS

# Lead might be most restrictive.

| ***Contaminant*** | *Assumed Degree of Treatment* | *Assumed Treatment, Allowable Stormwater Fraction* |
|---|---|---|
| ***Benzo(a)pyrene*** | 47% | 100% |
| ***Benzo(b)fluoranthene*** | 47% | 90% |
| ***Benzo(e) Pyrene*** | 47% | 100% |
| ***Chrysene*** | 47% | 90% |
| ***Copper*** | 55% | 100% |
| ***E. Coli*** | 100% | 100% |
| ***Fecal Coliform*** | 100% | 100% |
| ***Fluoranthene*** | 47% | 70% |
| ***Indeno(1,2,3-c,d)pyrene*** | 47% | 100% |
| ***Lead*** | **32%** | **40%** |
| ***Perylene*** | 47% | 100% |
| ***Pyrene*** | 47% | 70% |
| ***Turbidity*** | 100% | 100% |

# COSTS

# Storage accounts for more than 95% of capital costs for diversion.

| | Stormwater Fraction | | |
|---|---|---|---|
| | 10% | 40% | 100% |
| | **Conveyance Pipe** | | |
| **Urban runoff flow, MGD** | 3 | 12 | 30 |
| **Conveyance pipe size, inches** | 21 | 41 | 65 |
| **Pipe construction cost, $** | $730,000 | $1,425,000 | $2,076,000 |
| | **Storage Basin** | | |
| **Storage volume, acre-feet** | 9 | 37 | 91 |
| **Excavation cost at $32/ft$^3$, $** | $15,880,000 | $63,600,000 | $158,800,000 |
| | **Total Capital Cost** | | |
| **Total infrastructure cost** | **$16,700,000** | **$65,100,000** | **$161,000,000** |

# Treatment plant operating costs are less than 1% of capital costs.

| | Stormwater Fraction | | |
|---|---|---|---|
| | 10% | 40% | 100% |
| Annual stormwater volume, MG/year | 67 | 268 | 669 |
| Annual blended volume, MG/year | 669 | 669 | 669 |
| | | **Treatment** | |
| Alum, $/year | $25,205 | $72,167 | $166,091 |
| Caustic Soda, $/year | $0 | $2,930 | $19,931 |
| Polymer, $/year | $0 | $153 | $475 |
| Chlorine gas, $/year | $2,498 | $6,410 | $14,235 |
| | | **Sludge Removal** | |
| Alum usage, lbs/year | *118,612* | *339,610* | *781,607* |
| Sludge production, tons/year | 4,568 | 13,182 | 30,409 |
| Sludge removal, $/year | $68,072 | $196,434 | $453,158 |
| | | **Annual Operational Cost** | |
| Total operational costs per year | **$95,774** | **$278,093** | **$653,890** |

# 30-Yr life-cycle cost/acre is estimated at < $35,000/Acre.

| | *Stormwater Fraction* | | |
|---|---|---|---|
| | 10% | 40% | 100% |
| | *Drainage Areas (acres)* | | |
| | *522* | *2,088* | *5,221* |
| | *Cost* | | |
| Total infrastructure cost | $16,700,000 | $65,100,000 | $161,000,000 |
| Total operational costs per year | $95,774 | $278,093 | $653,890 |
| Total life-cycle cost, $ | $18,100,000 | $69,400,000 | $171,000,000 |
| **Total life-cycle cost per catchment area, $/acre** | **$34,700** | **$33,200** | **$32,800** |

# Green stormwater infrastructure case study cost is nearly $300,000/acre.

| | |
|---|---|
| Percent GSI area to impervious area | 4% |
| Catchment, percent impervious | 49% |
| GSI area per catchment area | 853 sq ft/acre |
| Installation Cost per GSI area | $183/sq ft |
| Total capital cost per catchment area | $157,000/acre |
| Annual GSI costs per catchment area, $/acre | $7,200 |
| 30-yr lifecycle cost, $/acre | $298,000 |

# 30-Yr life-cycle cost comparison indicates stormwater diversion may be much cheaper than GSI.

| | *Stormwater Fraction* | | |
|---|---|---|---|
| | 10% | 40% | 100% |
| *Drainage area, acres* | 522 | 2,088 | 5,221 |
| *Diversion to Drinking Water, $/acre* | $34,700 | $33,200 | $32,800 |
| *Green Stormwater Infrastructure, $/acre* | $298,000 | | |

# DISCUSSION

# OBSERVATIONS

- Diversion of stormwater to drinking water may just work!
- Diversion potentially less costly than GSI
- Diverted stormwater fraction could be limited by Pb MCL
- Substantial diversion requires new source water assessment and permitting
- Diversion is more feasible where drinking water treatment plants already treat higher source water concentrations

# FURTHER QUESTIONS

- Considering more scenarios across the state?
- Should we optimize gray and green infrastructure?
- What is a reasonable cap on opportunistic GSI cost?  What can we get with $30K/acre (e.g., curb-cutting, soil enhancements, and new plantings)?
- Is diversion more attractive where TMDLs will require major infrastructure?
- What are the policy and permitting hurdles?  How do we do a new source water assessment for urban runoff?
- How will a lower Pb MCL change costs?  Will advanced filtration be required at the treatment plant, regardless?
- Should POTW connections also be provided?*
- How would "Drains to Drinking Water" messaging improve public engagement and pollution prevention?

*https://www.casqa.org/sites/default/files/downloads/casqa_position_paper_-_ms4-potw_collaboration_-_august_2019.pdf

# FURTHERING THE CONVERSATION

- CASQA
- Governor's Office of Planning and Research
- SWRCB
- DWR-IRMWP
- ACWA
- Water districts
- Consultants preparing watershed improvement plans
- Counties
- Cities
- CSU facilities

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## Contact

brian.currier@owp.csus.edu
www.owp.csus.edu/research

WATER PROGRAMS at sacramento state