

# Project Memorandum #6: Approach to estimating the cost of levee upgrade strategies

Workshop Discussion Version

May 19, 2016

As described in Project Memorandum #4, the first step in determining the feasibility of financial mechanisms is to determine the program or project funding needs. For this Feasibility Study, our team must make reasonable assumptions about future levee improvements, the level of funding that will be required, and the timing of the investment program. We need to consider, for example, whether a financial mechanism, such as a user fee or a tax, needs to support modest investments in levee maintenance and incremental upgrades, spread out over many years. Alternatively, there could be a need for a substantial amount of revenue to bring flood protection up to current state and federal standards, such as that being undertaken by the Sacramento Area Flood Control Agency, to be undertaken in a relatively short timeframe.

This study uses five Archetypes<sup>1</sup> to evaluate financing mechanisms. Each of the Archetypes comprise assorted Delta levee beneficiaries with varying degrees of risk tolerance and requirements for levee improvements, and consequently, different funding needs. In order to analyze the feasibility of financing mechanisms to pay for a range of investments, we have developed cost estimates for two “bookend” scenarios—low-cost and high-cost—for levee improvements. This memo explains the source of the cost estimates and associated uncertainties.

## SOURCE OF COST ESTIMATES

We assume that a lower-cost investment scenario could be based on upgrading levees to PL84-99 status, using modified cost estimates from the DRMS effort as a starting point.<sup>2</sup>

Alternatively, the Delta Levee Investment Strategy (DLIS) project has developed new set of cost estimates for PL84-99 levee upgrades, based on both the cost of fill material and the cost per linear mile of levee. For a more expensive investment scenario, we use the DRMS estimates for raising levees to urban levee standards. Assuming that the DRMS “Urban Levee Standard” is roughly equivalent to recent DWR levee standard guidance, then that scenario potentially entails 200-year level of flood protection, with approximately three feet of freeboard above the design flood elevation.

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<sup>1</sup> See Project Memorandum #3 on Archetypes, available at [http://www.delta.ca.gov/Flood\\_Risk\\_Assessment.htm](http://www.delta.ca.gov/Flood_Risk_Assessment.htm).

<sup>2</sup> We modified DRMS costs for two reasons: first, DRMS did not develop costs for all islands, so the team developed assumptions to fill these gaps. Second, DRMS was completed almost a decade ago, and the team applied its collective experience to update key cost assumptions, e.g., the cost of levee fill.

We do not assert in this study that the higher cost scenario will produce an adequate level of flood protection (for example, it would not reflect more recent higher estimates of sea-level rise, and the upgrades do not provide for seismic protection); but these figures represent a reasonable upper bound for our purposes.

Each of this study’s five Archetypes was created using representative islands for which DRMS data is available. Table 1 shows the wide variance in the low-cost scenario, depending on whether we choose the DRMS or DLIS PL84-99 cost estimates. Consequently, the cost difference between the low- and high-cost scenarios ranges from approximately 400% to nearly 900%. Low- and high-cost scenario estimates for all Archetypes (based on our assumptions about the composition of the Archetypes and how DRMS cost estimates should be modified to fit the Archetypes) are summarized below.

**Table 1: Range of Levee Improvement Cost Estimates by Archetype**

	DLIS PL84-99 Cost, \$15/yd <sup>3</sup> \$Millions	DLIS PL84-99 Cost, 1.5M\$/mile \$Millions	Modified DRMS PL84-99 Cost \$Millions	Modified DRMS Urban Levee Standard Cost \$Millions
Archetype 1	14	48	120	488
Archetype 2	8	26	106	564
Archetype 3	116	240	469	2,089
Archetype 4	5	10	23	205
Archetype 5	8	26	50	295

## UNCERTAINTY OF COST ESTIMATES

The DRMS urban levee cost estimates are large, yet likely do not include other costs such as habitat mitigation, infrastructure repair due to truck and equipment hauling, or traffic impacts and mitigation. The urban levee scenario would require approximately 50 million cubic yards or more of fill material, and we have not confirmed the availability or cost of that fill.<sup>3</sup>

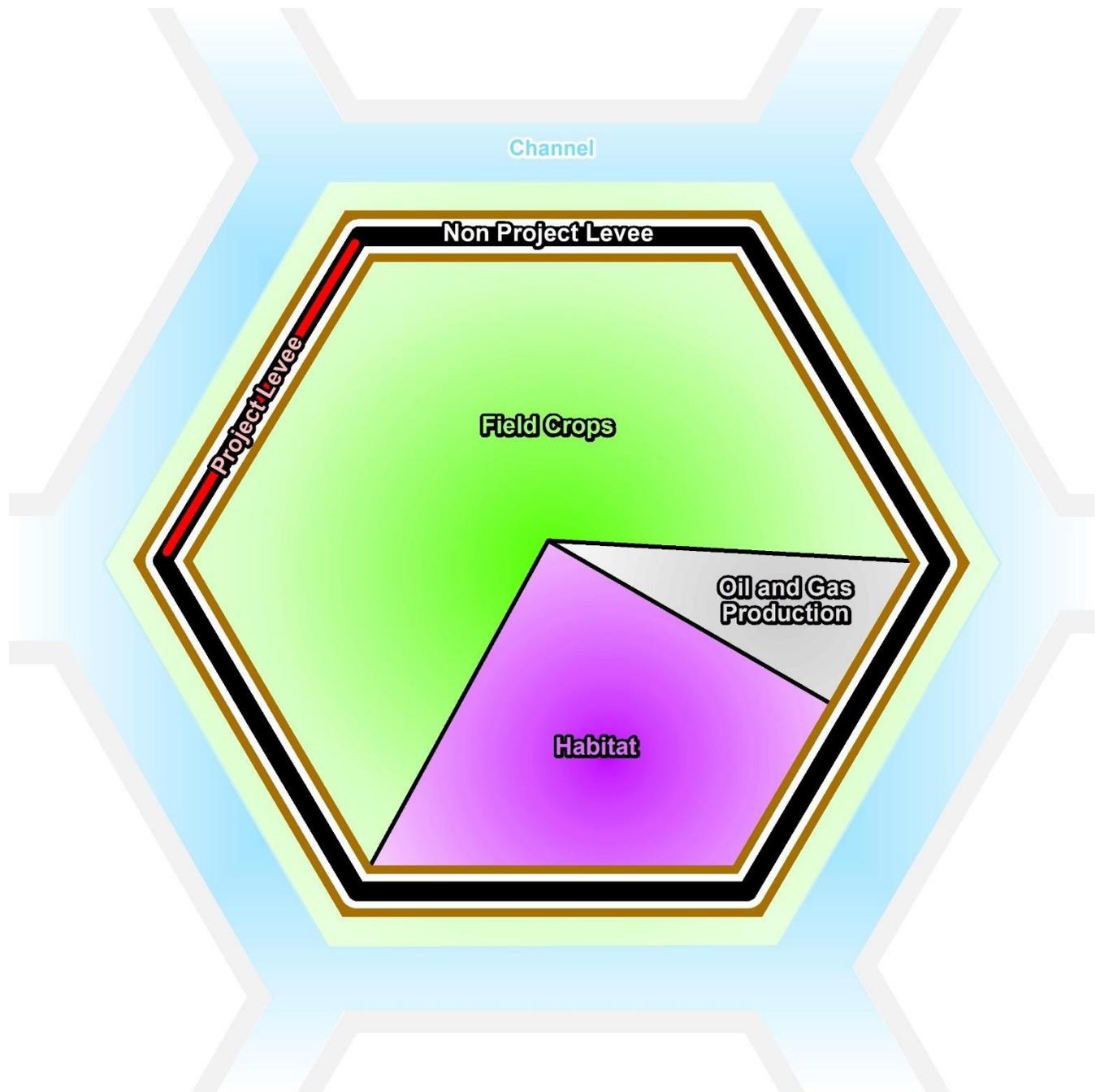
Table 2 shows the total, average, and unit costs for all scenarios on each Archetype. The costs by Archetype using the DLIS PL84-99 information vary from approximately 10 to 50 percent of the cost as estimated from the DRMS information. Assumptions regarding material availability, other potential costs for mitigating habitat or traffic impacts, and other details are not readily apparent in the descriptions of the DLIS cost estimates. Some of the DLIS PL84-99 total costs seem low based on the team’s experience.

Following Table 2, we include the diagram of each Archetype, along with the range of total costs for the four scenarios.

<sup>3</sup> The PL 84-99 estimate in DRMS is stated as a “repair” cost to bring the levees to an acceptable standard. (We do not have an entirely clear interpretation of what those standards are). The cost for the three-foot raise is based on a volume calculation of raising the levee crest and sideslopes, and applying either a \$6.50 or \$20 per cubic yard for embankment earth

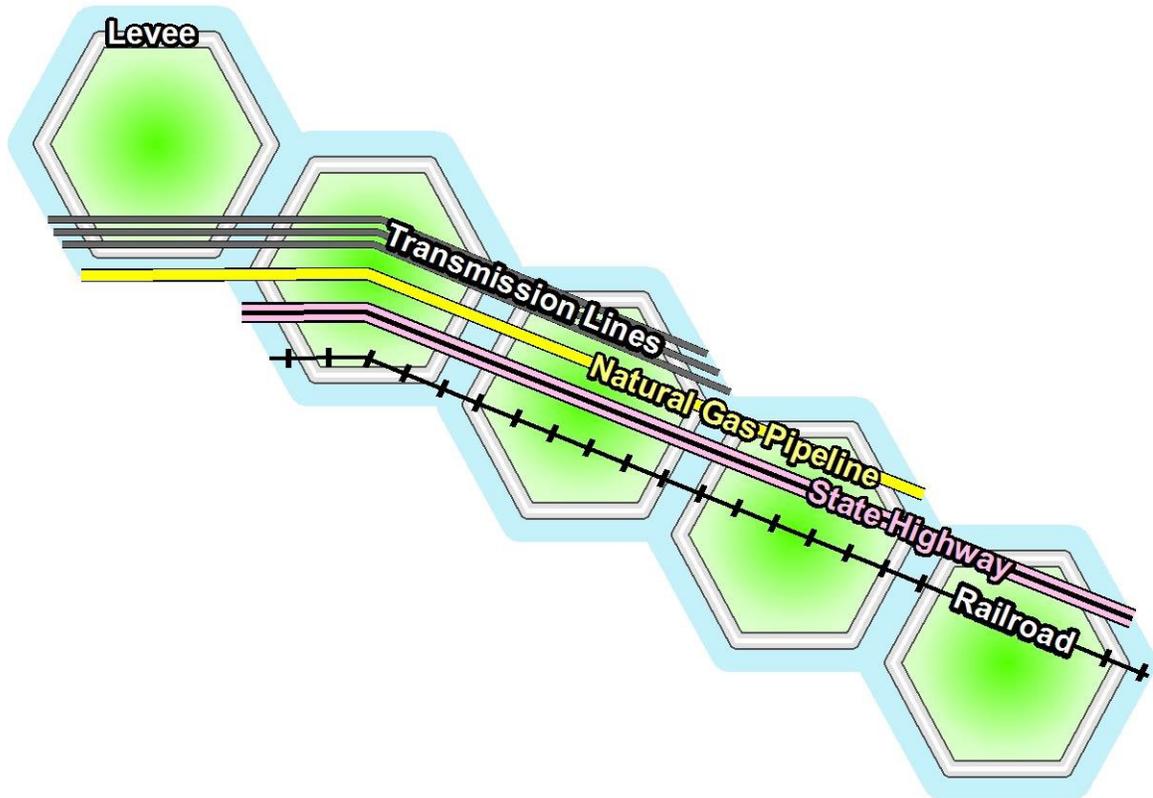
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Table 2 - Cost Estimates for Levee Upgrades by Archetype									
Archetype	Island	levee miles	Cost PL84-99 Upgrade (in millions)		DLIS PL84-99		Cost Urban Levee Upgrade (in millions)		
			\$/mi*	Composite	\$15/yd^3	1.5M\$/mile	\$/mi #	Total	\$ Urban / \$ PL84
<b>Archetype 1</b>									
	All Island - Averages	11.92	\$2.64	\$31			\$10.3	\$123	
	All Island - Total	<b>47.69</b>	<b>\$2.52</b>	<b>\$120</b>	<b>\$14</b>	<b>\$48</b>	<b>\$10.2</b>	<b>\$488</b>	<b>405%</b>
<b>Archetype 2</b>									
	All Island - Averages	12.07	\$1.38	\$17			\$9.4	\$113	
	All Island - Total	<b>60.36</b>	<b>\$1.75</b>	<b>\$106</b>	<b>\$8</b>	<b>\$26</b>	<b>\$9.3</b>	<b>\$564</b>	<b>535%</b>
<b>Archetype 3</b>									
	All Island - Averages	13.11	\$2.07	\$27			\$9.3	\$122	
	All Island - Total	<b>222.85</b>	<b>\$2.10</b>	<b>\$469</b>	<b>\$116</b>	<b>\$240</b>	<b>\$9.4</b>	<b>\$2,089</b>	<b>445%</b>
<b>Archetype 4</b>									
	All Island - Averages	5.80	\$1.15	\$7			\$8.9	\$52	
	All Island - Total	<b>23.19</b>	<b>\$1.01</b>	<b>\$23</b>	<b>\$5</b>	<b>\$10</b>	<b>\$8.8</b>	<b>\$205</b>	<b>874%</b>
<b>Archetype 5</b>									
	All Island - Averages	5.62	\$1.36	\$8			\$8.7	\$49	
	All Island - Total	<b>33.69</b>	<b>\$1.49</b>	<b>\$50</b>	<b>\$8</b>	<b>\$26</b>	<b>\$8.8</b>	<b>\$295</b>	<b>589%</b>



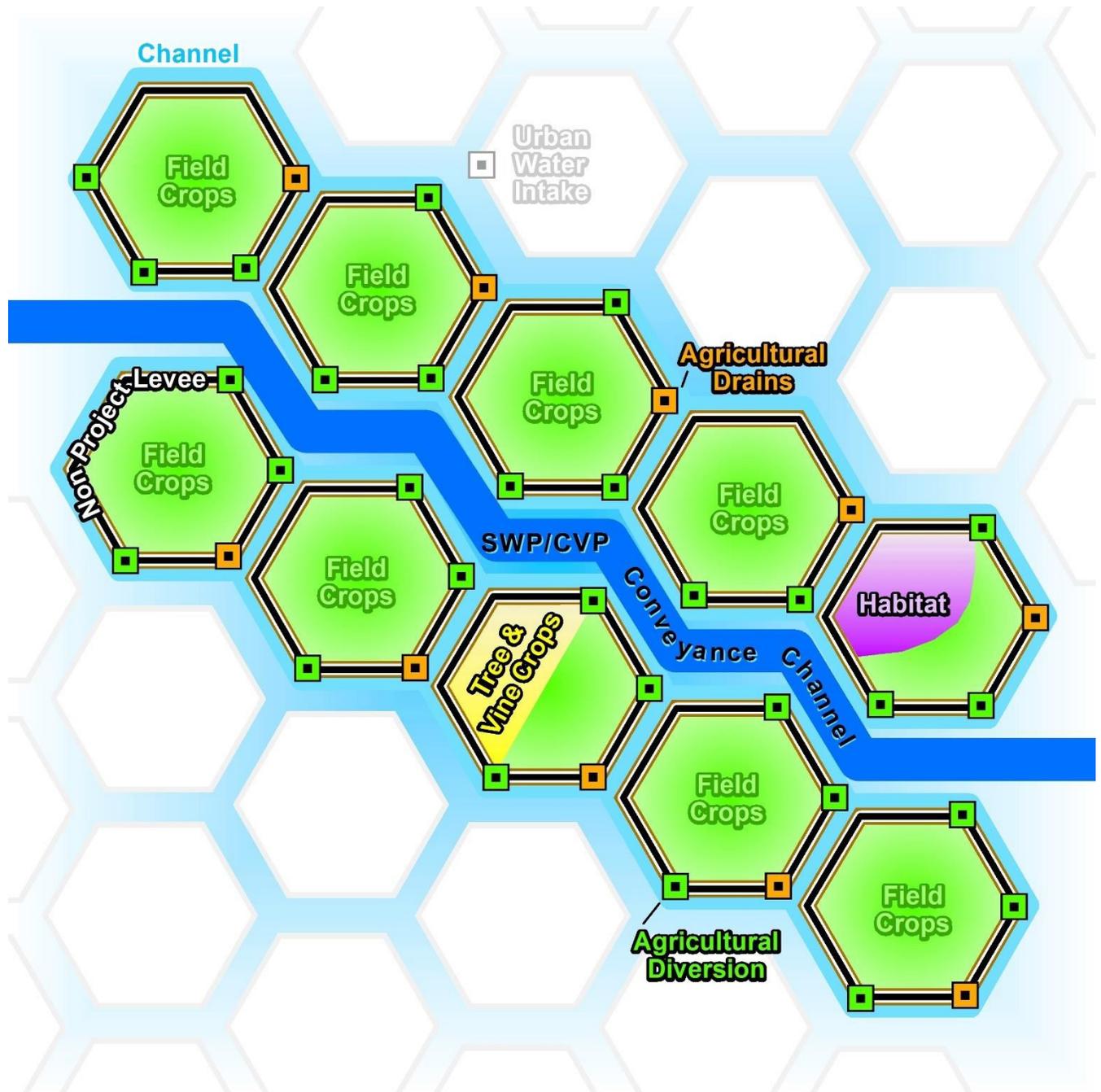
**Archetype 1 – Agricultural Emphasis**

	DLISPL84-99Cost, \$15/yd <sup>3</sup> \$Millions	DLISPL84-99Cost, 1.5M\$/mile \$Millions	Modified DRMSPL84- 99Cost \$Millions	Modified DRMS Urban Levee Standard Cost \$Millions
Archetype 1	14	48	120	488



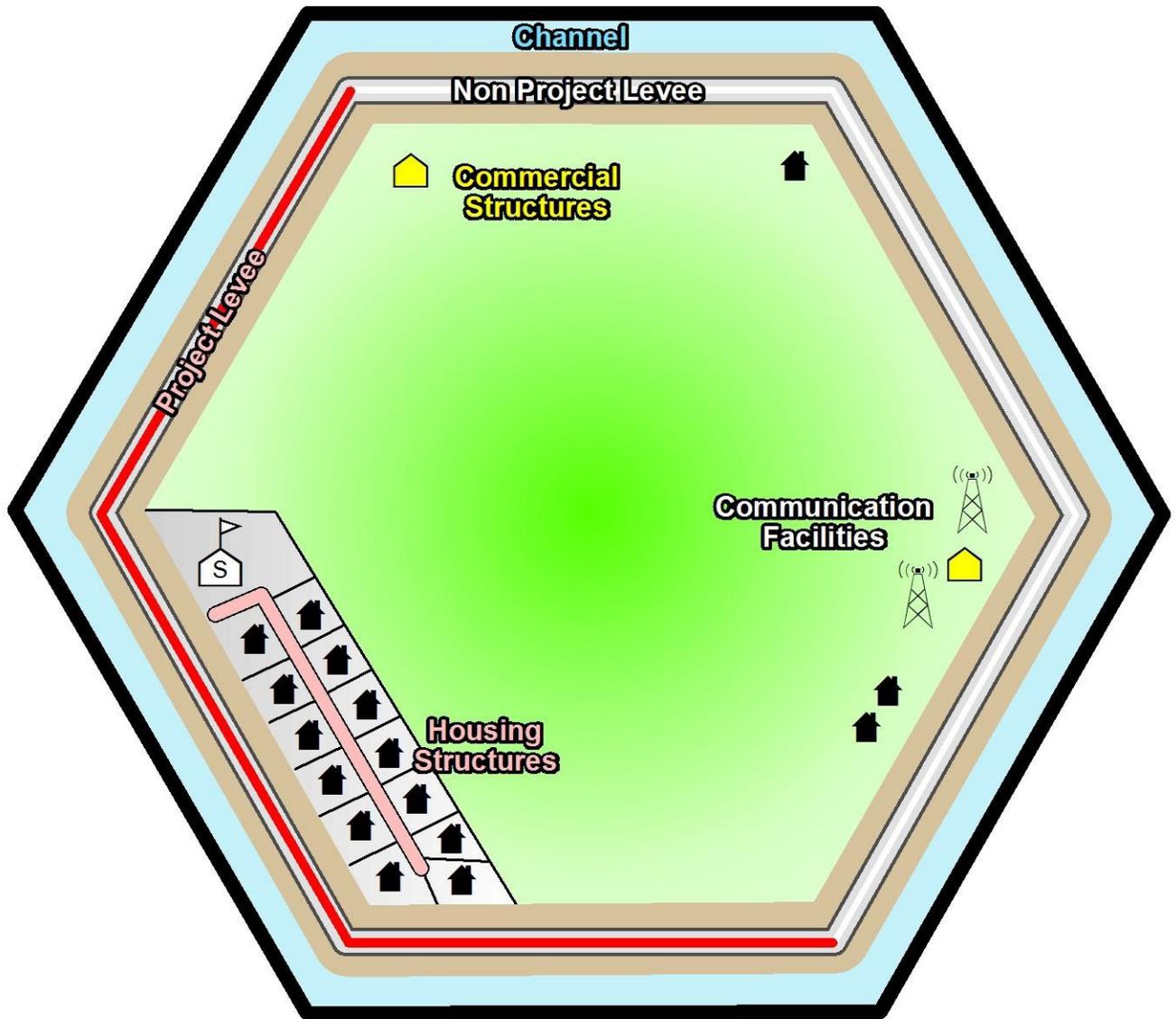
**Archetype 2- Cross Delta Infrastructure**

	DLISPL84-99Cost, \$15/yd <sup>3</sup> \$Millions	DLISPL84-99Cost, 1.5M\$/mile \$Millions	Modified DRMSPL84- 99Cost \$Millions	Modified DRMS Urban Levee Standard Cost \$Millions
Archetype 2	8	26	106	564



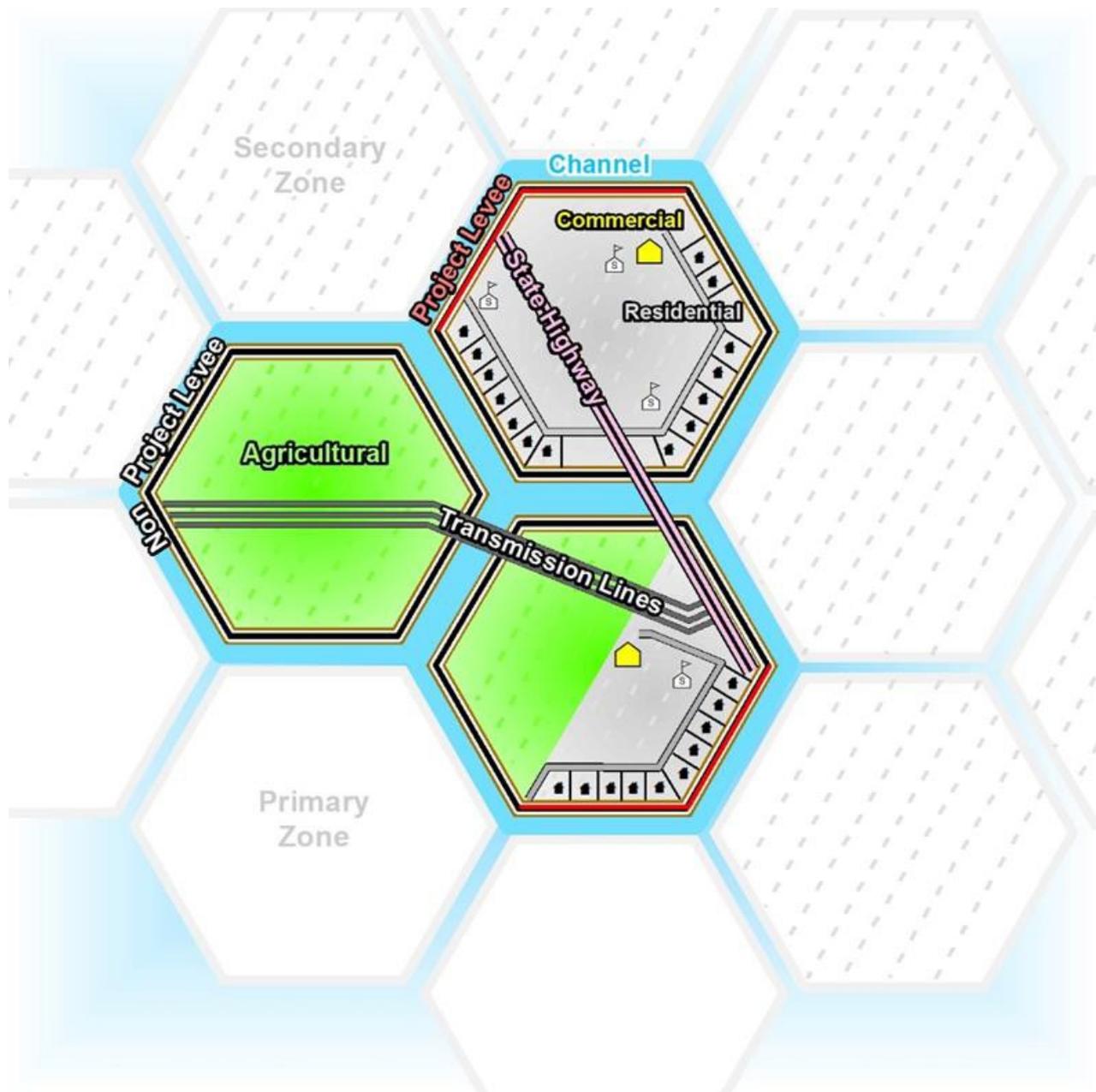
Archetype 3- Water Conveyance

	DLISPL84-99Cost, \$15/yd <sup>3</sup> \$Millions	DLISPL84-99Cost, 1.5M\$/mile \$Millions	Modified DRMSPL84- 99Cost \$Millions	Modified DRMS Urban Levee Standard Cost \$Millions
Archetype 3	116	240	469	2,089



**Archetype 4 – Smaller Communities**

	DLISPL84-99Cost, \$15/yd <sup>3</sup> \$Millions	DLISPL84-99Cost, 1.5M\$/mile \$Millions	Modified DRMSPL84- 99Cost \$Millions	Modified DRMS Urban Levee Standard Cost \$Millions
Archetype 4	5	10	23	205



**Archetype 5 – Urban in Secondary Zone**

	DLISPL84-99Cost, \$15/yd <sup>3</sup> \$Millions	DLISPL84-99Cost, 1.5M\$/mile \$Millions	Modified DRMSPL84- 99Cost \$Millions	Modified DRMS Urban Levee Standard Cost \$Millions
Archetype 5	8	26	50	295