SFWMM Training

Miami-Dade Area

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Overview

- Modified Water Deliveries and C-111 Projects
- Restudy modifications to MWD, C111
- C-111 Spreader Canal
- Reuse
- Levee Seepage and Groundwater Flow
- Bird Drive Recharge Area

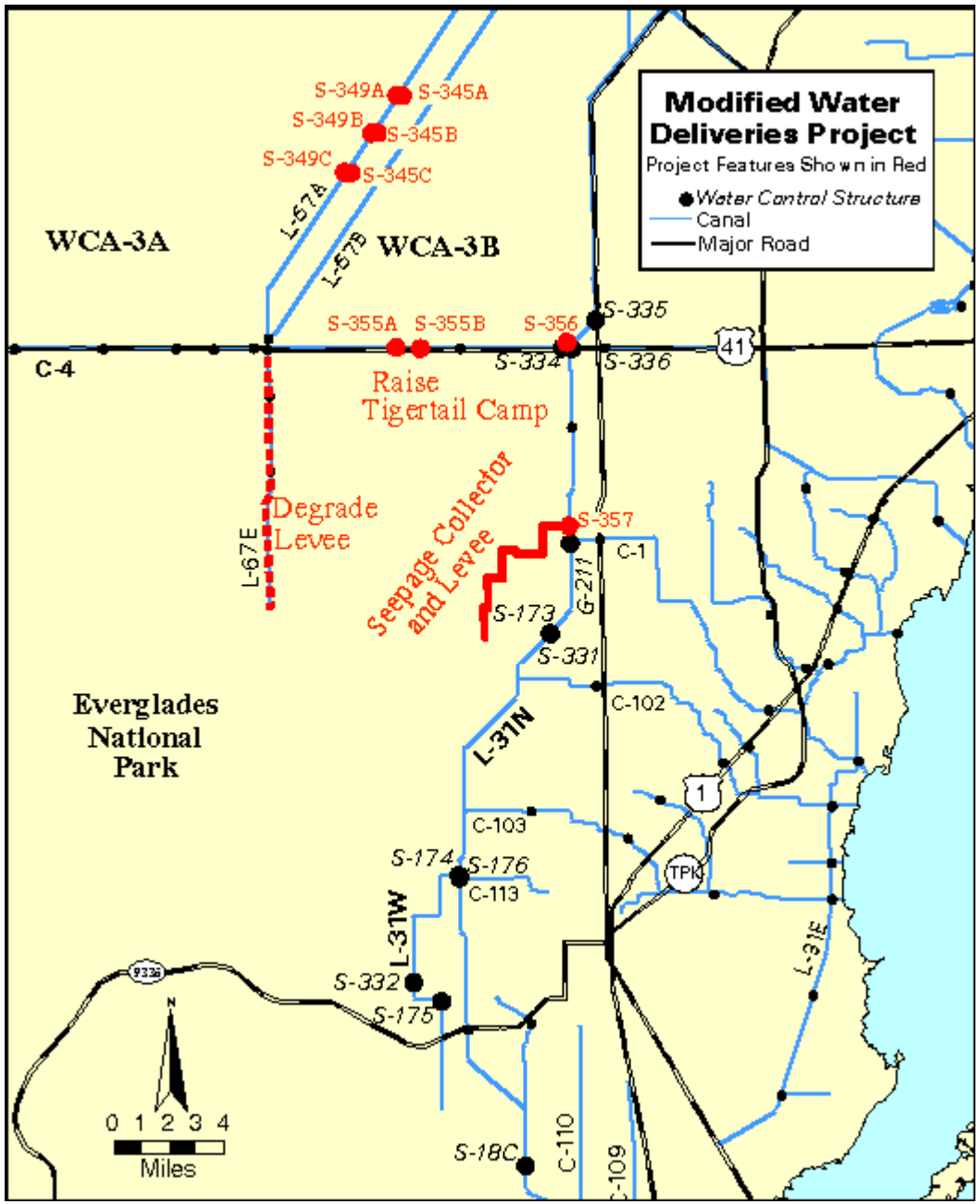
Modified Water Deliveries Project

ENP Protection and Expansion Act ‘89

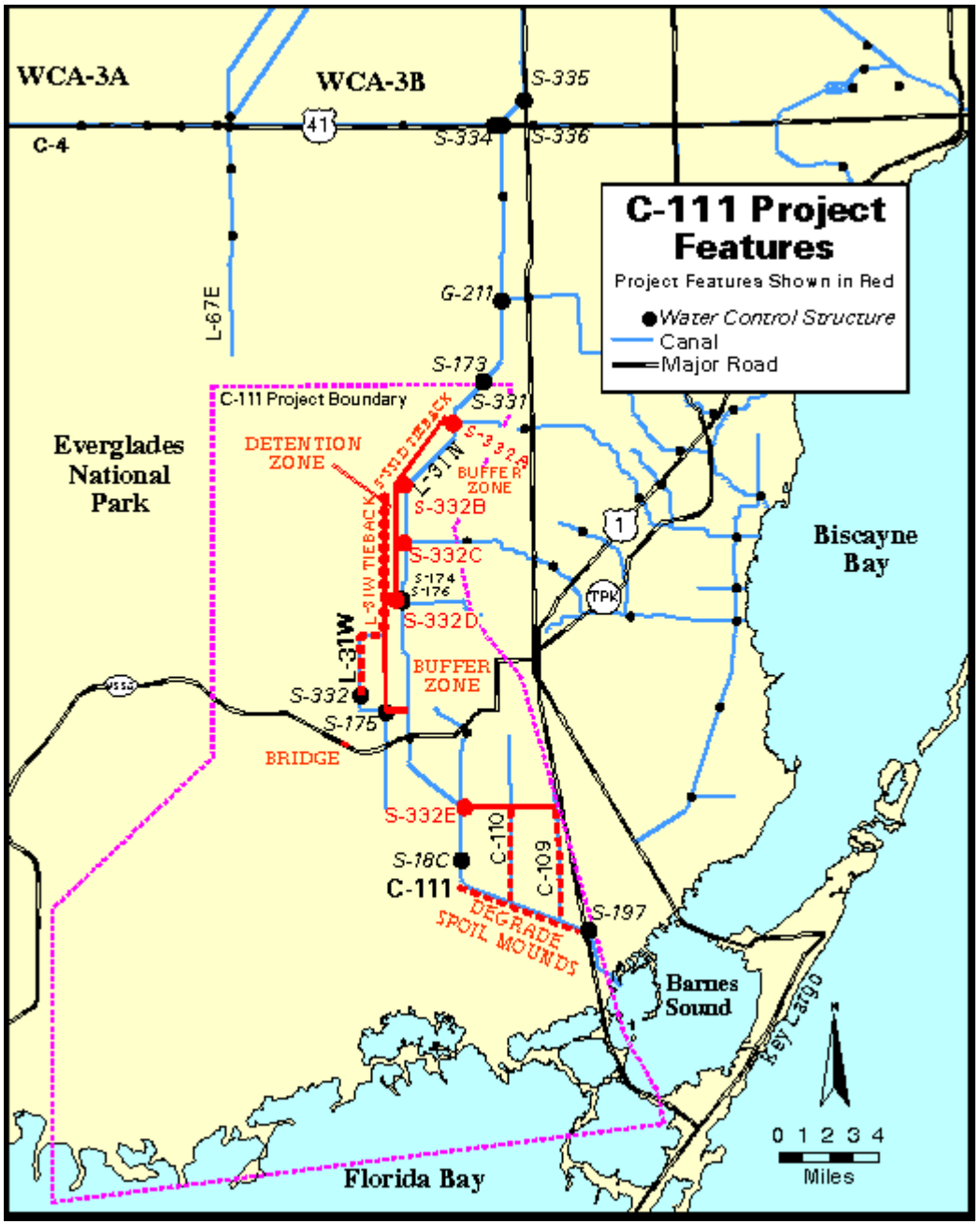
“ Construct modifications to C&SF to improve water deliveries into the park and shall, to the extent practicable, take steps to restore the natural hydrological conditions within the park.”

MWD Project

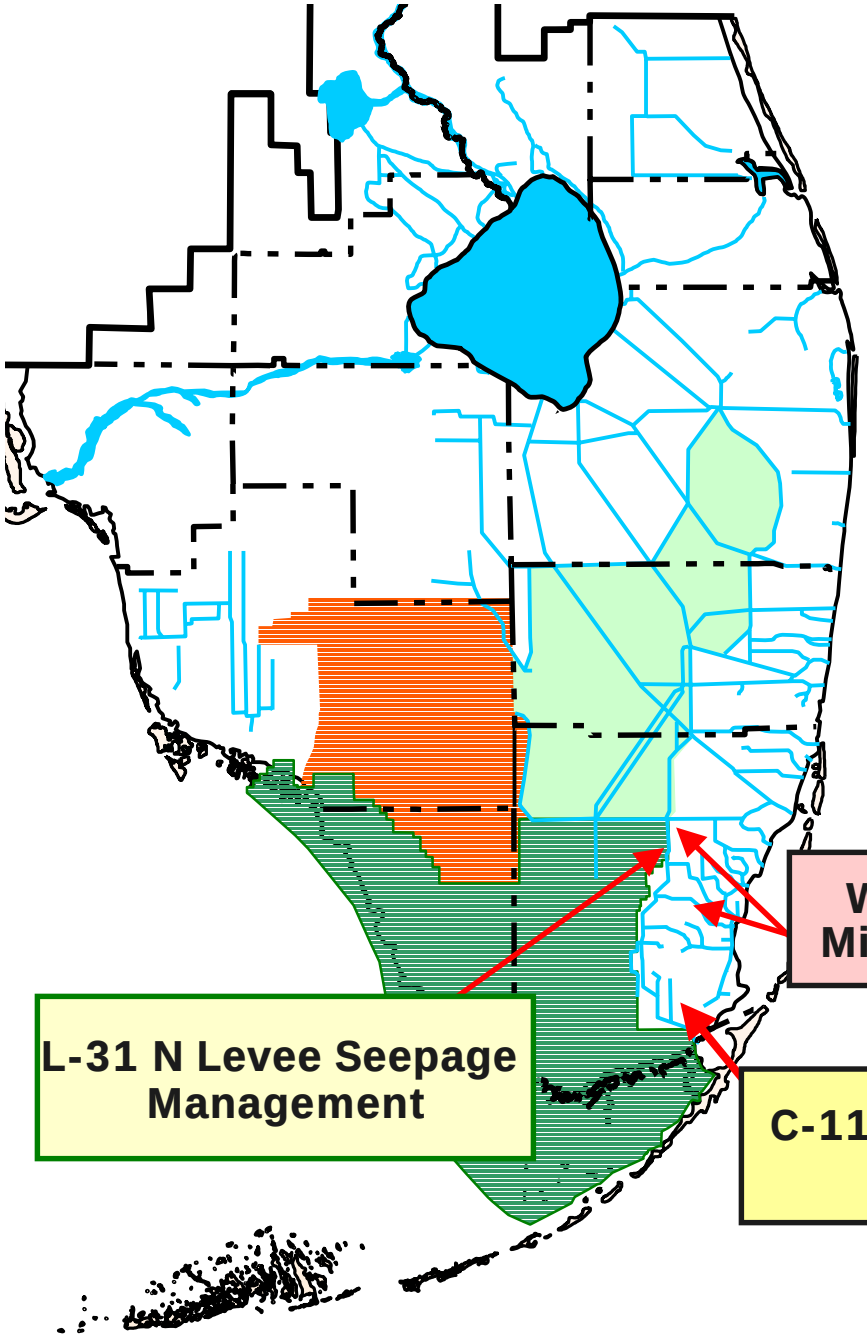
- 8.5 SMA
- Tamiami Trail Modifications
- Conveyance and Seepage Control Features



C-111 Project



Selected Comprehensive Everglades Restoration Plan (CERP) Components in Miami-Dade



West and South Miami-Dade Reuse

L-31 N Levee Seepage Management

C-111N Spreader Canal

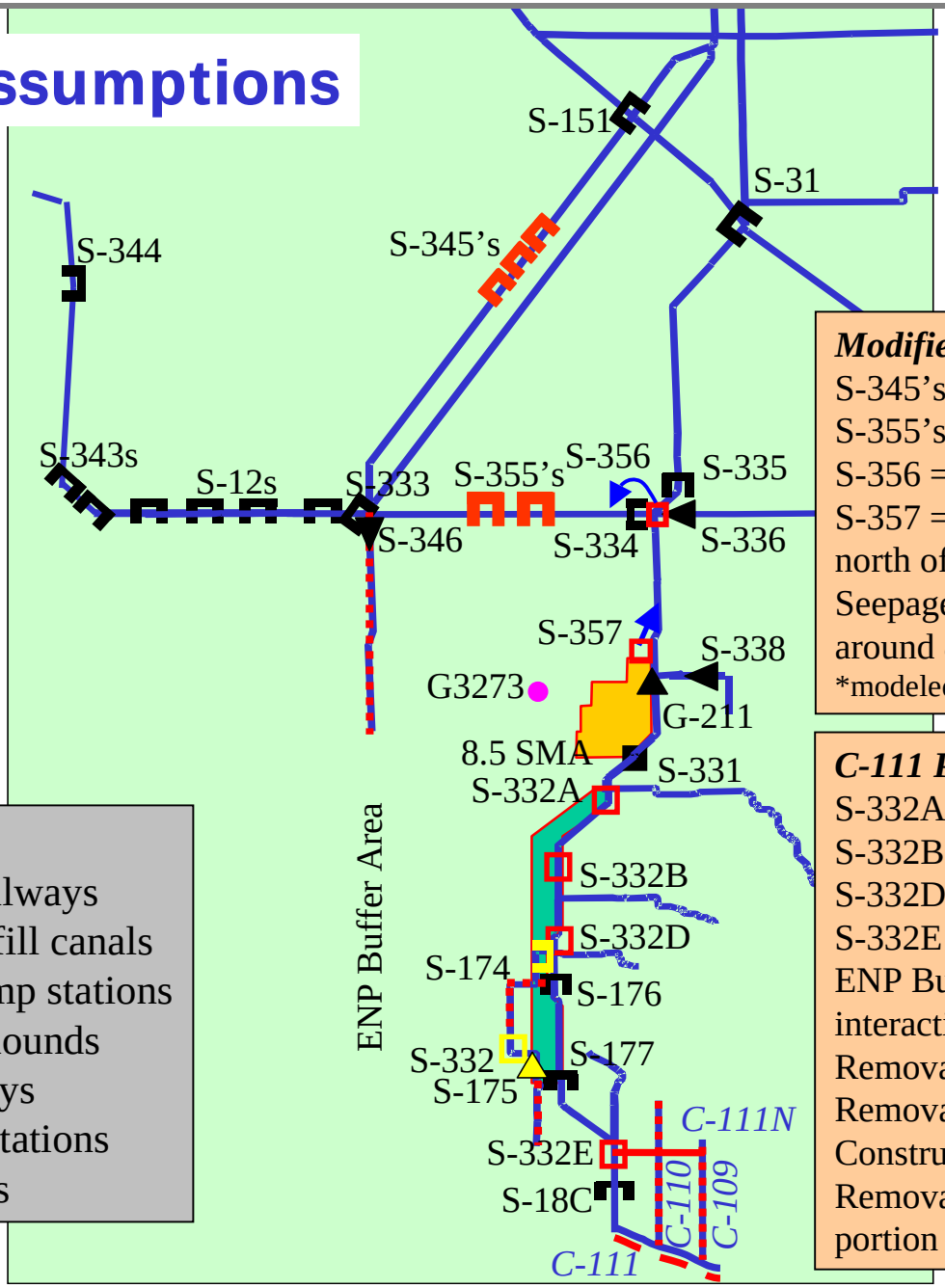
Canal and Structure Modifications

Reuse

Seepage Management

Modified Water Deliveries and C-111 Projects

Modeling Assumptions



MWD grids

- ***No*** G3273 constraint on S-355 and S-333
- L-29 8.0' constraint on S-355 and S-356 and S-333

Modified Water Deliveries Project
S-345's = 3 x 500 cfs*
S-355's = 2 x 1000 cfs*
S-356 = 900 cfs pumping to L-29
S-357 = 400 cfs pumping to L-31N north of G-211
Seepage collector canal and levee around 8.5 sma
*modeled as a single structure in 2x2

C-111 Project
S-332A = 300 cfs
S-332B = 400 cfs
S-332D = 500 cfs
S-332E = 50 cfs
ENP Buffer Area-no overland flow interaction
Removal of S-174, S-175, S-332
Removal of *C-109* and *C-110*
Construction of *C-111N*
Removal of spoil mounds on portion of *C-111*

Proposed
- Construction of spillways
- Degrade levee and fill canals
- Construction of pump stations
- Removal of spoil mounds
- Removal of spillways
- Removal of pump stations
- Removal of culverts

Input changes to add Modwaters Project (as in RESTUDY 2050 Base)

- **Add S-345's**
  - **caoflpts:** Add S345 to section with WCA-3A outlet structures (increase # of WCA-3A outlet structures)
  - **lecdef:** Add S345 to structure master list
  - **kflpts:** Add S345 flow source and destination
- **Add S-355's**
  - **canal22:** Add S355U canal segments
  - **cndta22:** Add S355U canal and S355 outlet structure
  - **lecdef:** Add S355 to structure master list
- **Add S-356 pump**
  - **cndta22:** Add S356 as L31NC outlet structure (into L29) and increase # of L31NC outlet structures by 1

    S336, S338, and G211 are operated at higher FC stages, so S356 has priority
  - **lecdef:** Add S356 to structure master list

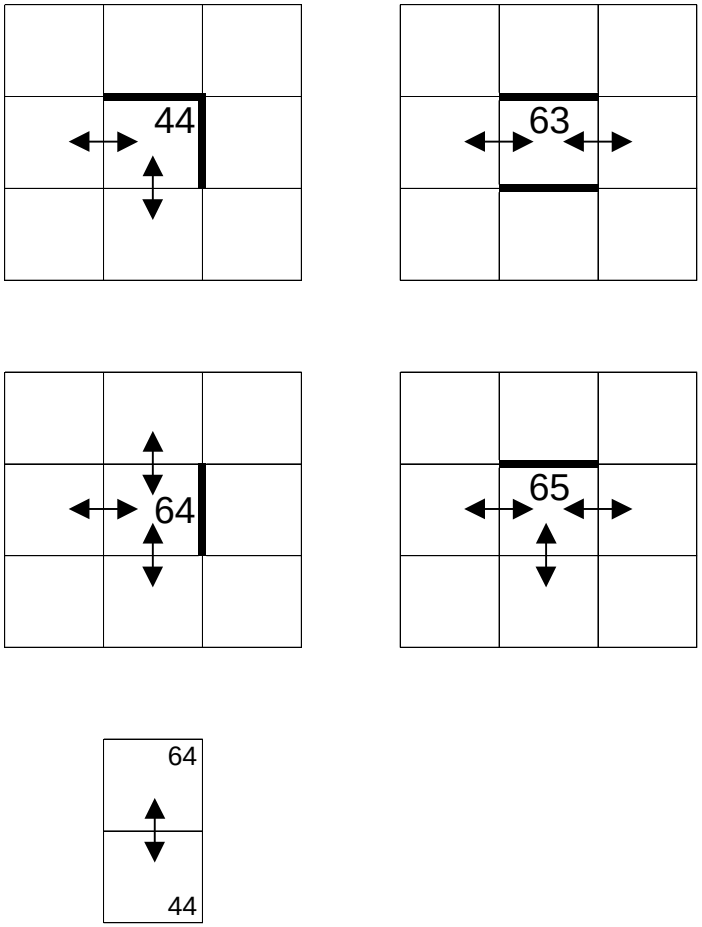
Input changes to add Modwaters Project (as in RESTUDY 2050 Base) Cont….

- **Degrade L-67 Extension Levee and Remove L-67 Canal**
  - **statdta:** Change CBN of 4 cells from 44 (special) to 6 to allow east-west flow
  - **canal22:** Remove L67E canal segments
  - **cndta22:** Remove L67E canal

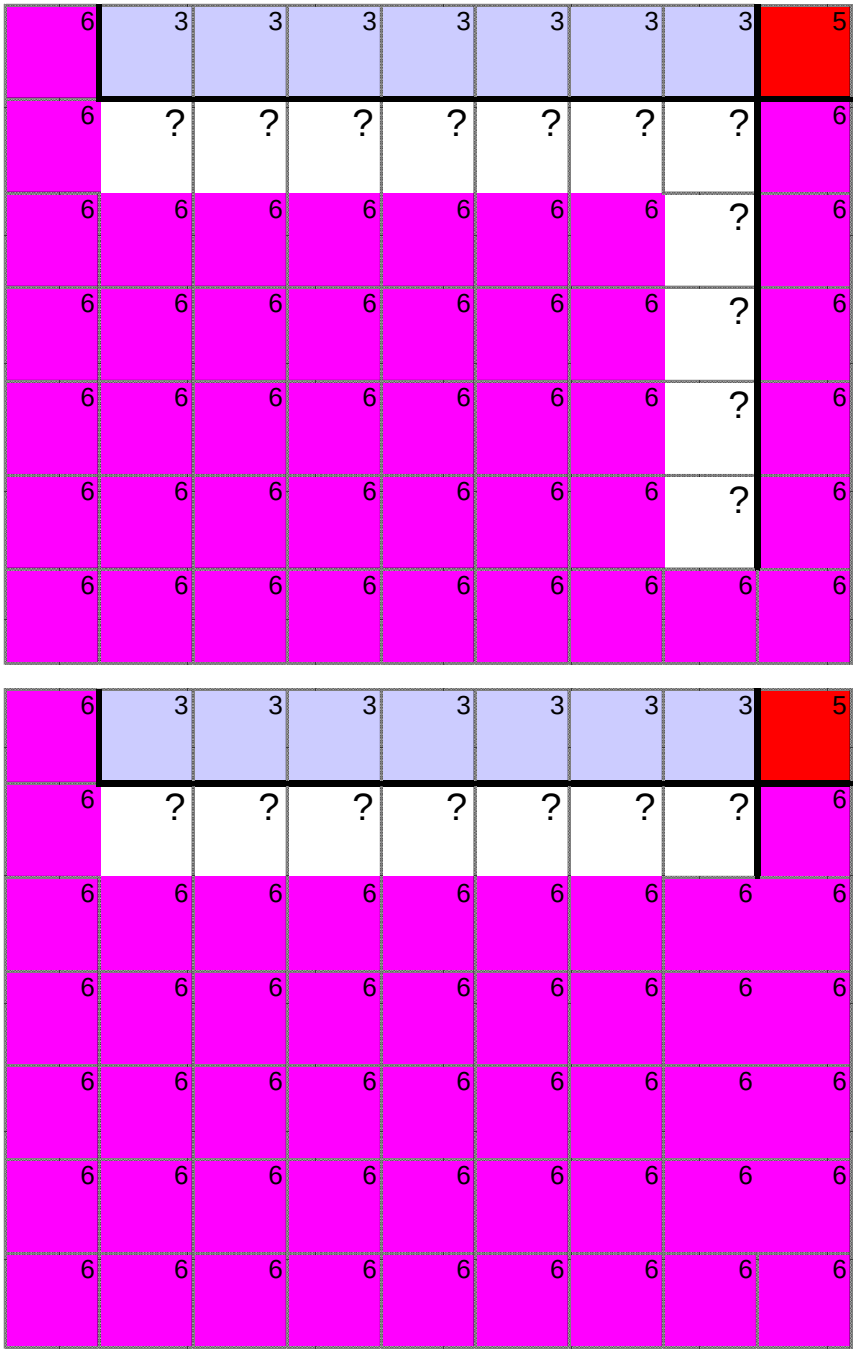
CBN = Hydrologic Basin Number

- Different CBN numbers - No overland flow interaction across face
- Same CBN number - Overland flow across face

SPECIAL CBN CODES



EXAMPLE



CBN = Hydrologic Basin Number

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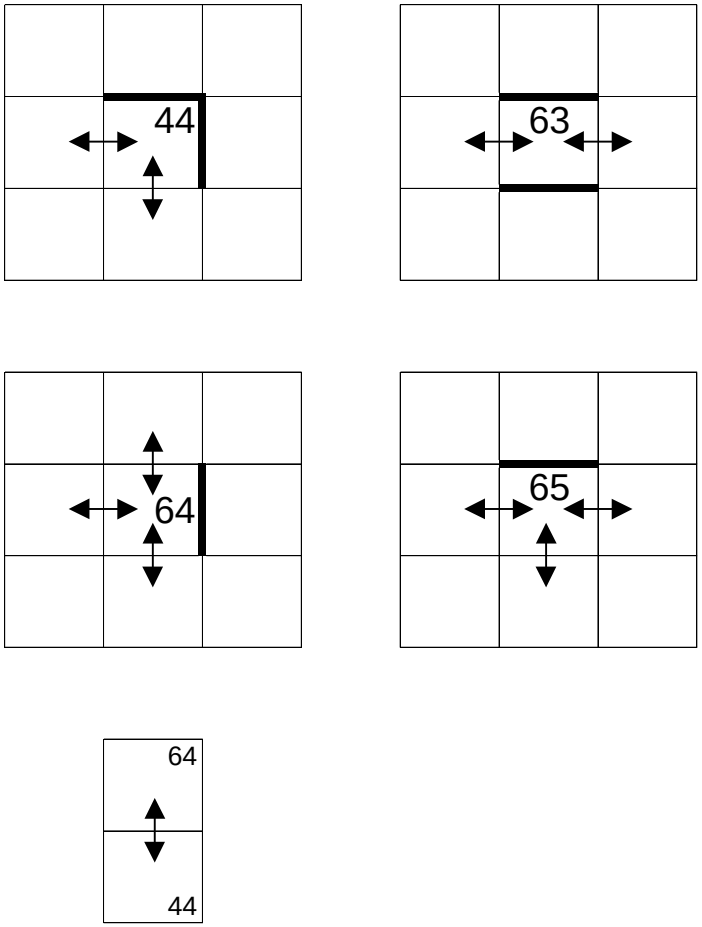
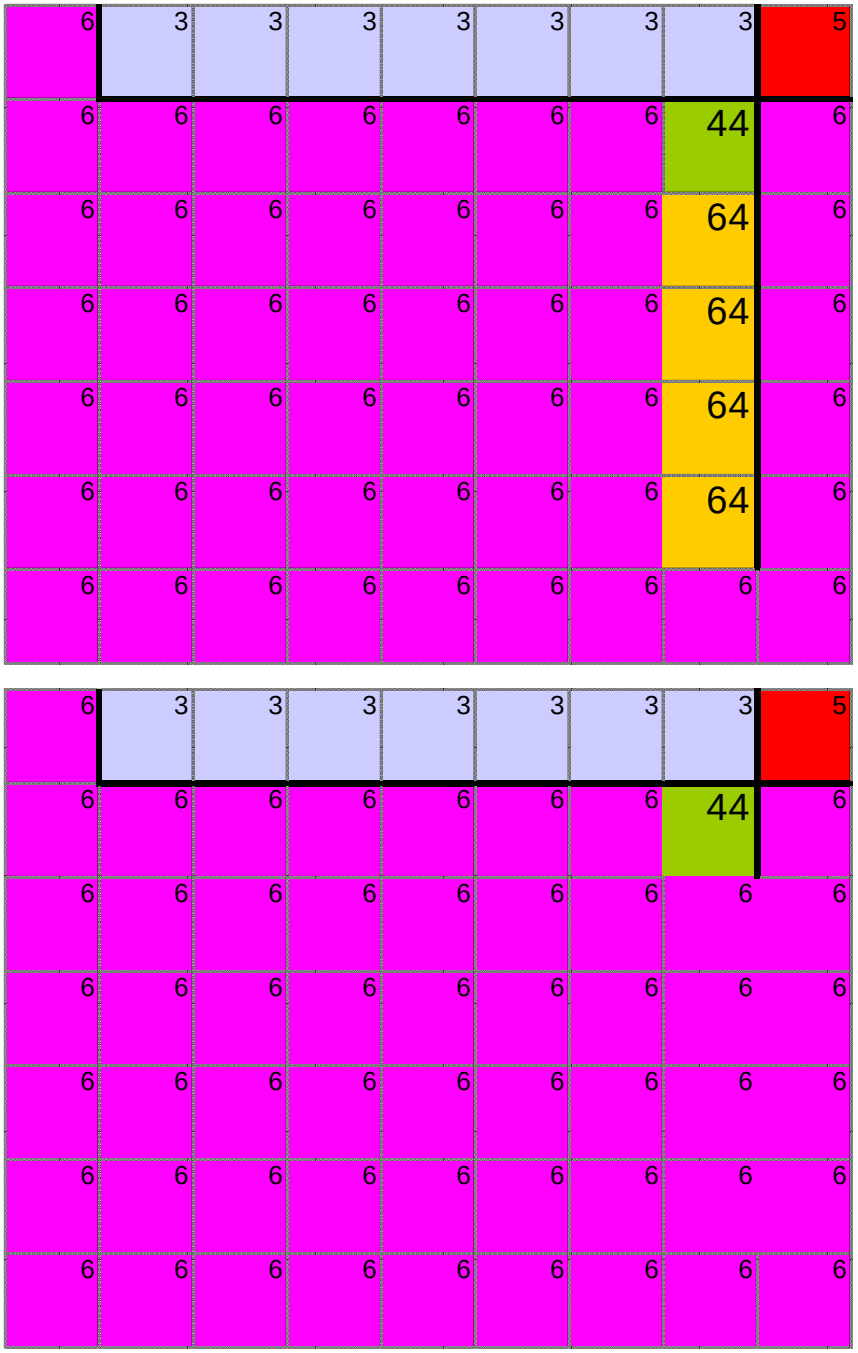
SPECIAL CBN CODES



EXAMPLE



CBN = Hydrologic Basin Number

- Different CBN numbers - No overland flow interaction across face
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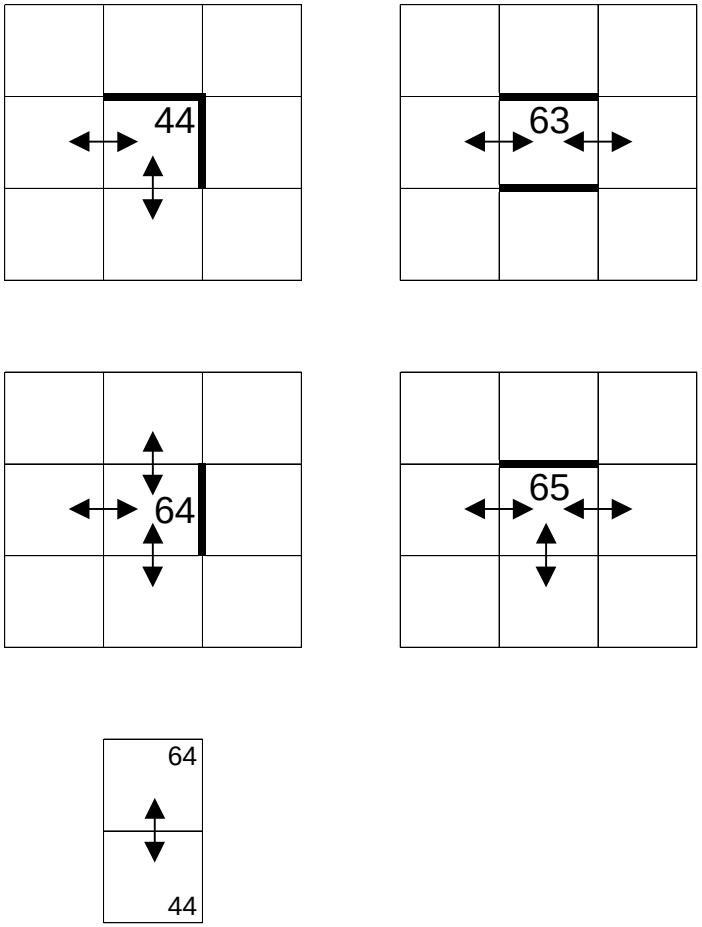
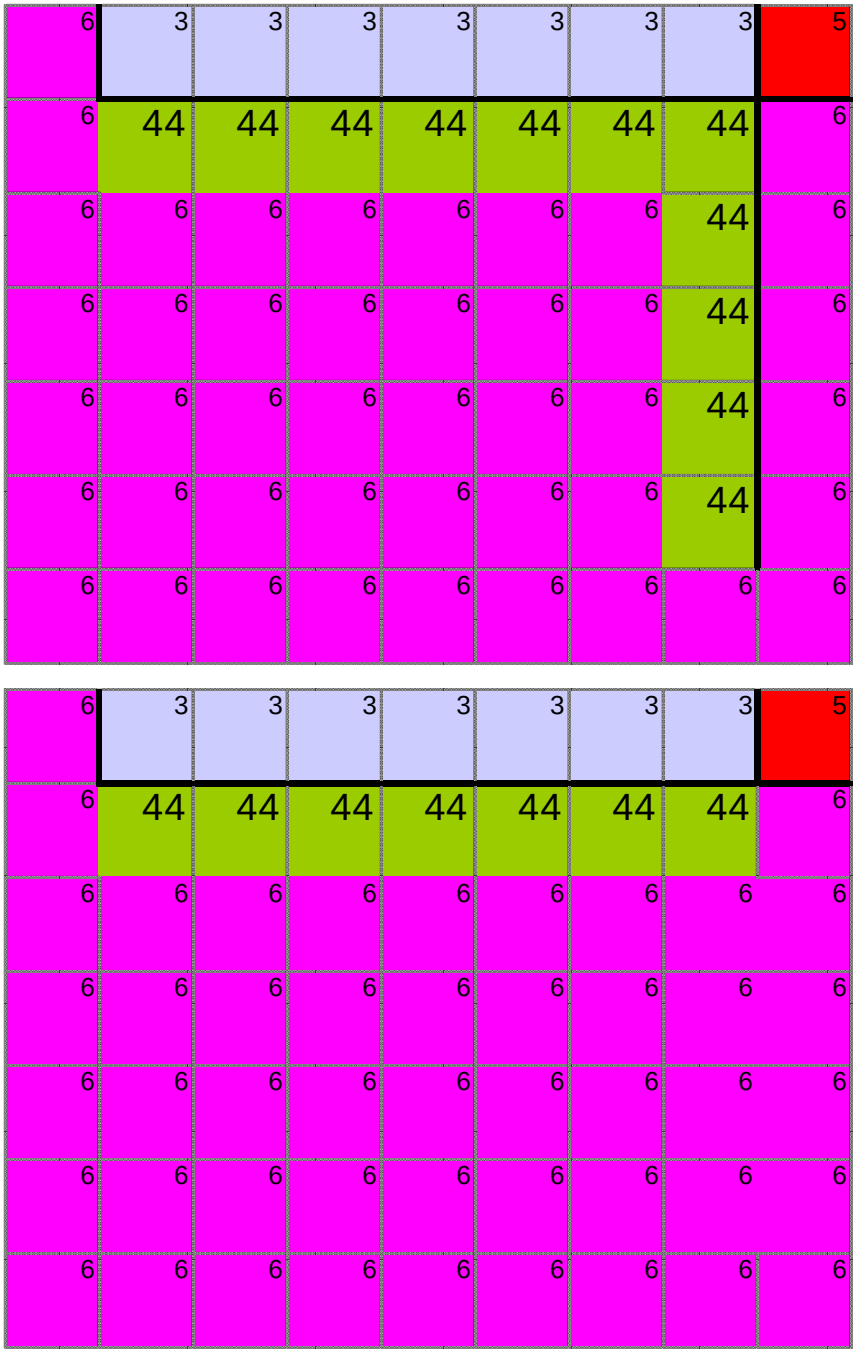
SPECIAL CBN CODES

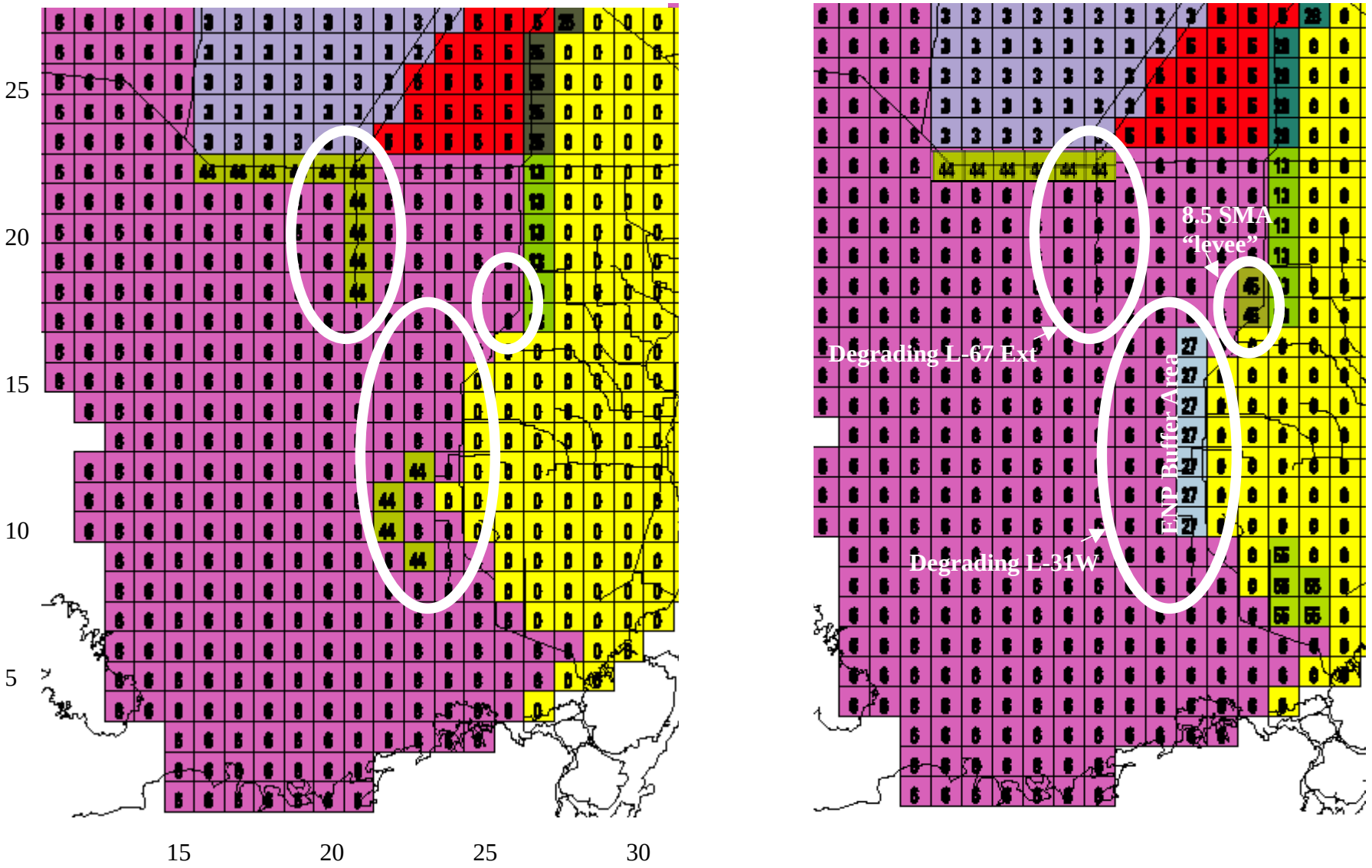


EXAMPLE



LEC: 95BSRR

AUTH
(MWD & C111)



Statdta: CBN changes

Input changes to add Modwaters Project (as in RESTUDY 2050 Base) Cont….

- **8.5 SMA: Add levee, seepage collector canal and S-357 pump**
  - **statdta:** Levee modeled by changing CBN of 2 cells from 6 to 45 to avoid overland flow interaction with ENP (seepage collector canal → modeled as no levee seepage)
  - **canal22:** Add RESC canal segments
  - **gen_nodal_dep_struc.dat:** Add S357 (flow depends on stage at 8.5 SMA grid cells)
  - **lecdef:** Add S357 to structure master list
  - **kflpts:** Add S357 source and destination of flow
  - **cndta22**: Since 8.5 SMA is protected, G3273 constraint on S333 is removed

Input changes to add C-111 Project (as in RESTUDY 2050 Base)

- **Add ENP Buffer Strip**
  - **statdta:** Change CBN of 7 cells to 27
  - **reservoir:** Add ENPBUF and outlet weirs and increase number of reservoirs by 1
- **Remove portion of C-111 Canal in ENP Buffer Strip**
  - **canal22:** Remove 1 segment of C111

Input changes to add C-111 Project (as in RESTUDY 2050 Base) Cont….

- **Fill L-31W Canal and degrade levee**
  - **cndta22:**Remove S332 and S175 structures from L31W and decrease # of L31W outlet structures to 0

    Remove S175D canal and S175 outlet structure

    Remove S174 and decrease # of L31S outlet structures by 1

    Add CULV as water supply/flood control structure from C111 into L31W and increase # of C111 outlet structures by 1

    S177 (from C111 into C111E) is operated at higher FC stages, so CULV has priority for FC discharge
  - **lecdef:** Add CULV to structure master list
  - **canal22:** Move L31W canal after C111 (C111 supplies water to L31W)

    Remove 3 segments of L31W

    Remove S175D canal
  - **statdta:** Change CBN of 4 cells from 44 to 6 to allow free overland flow interaction with ENP

Input changes to add C-111 Project (as in RESTUDY 2050 Base) Cont….

- **Add S-332A, B, D pumps into ENP Buffer Strip**
  - **cndta22:** Add S332A, B and D pumps as L31S outlet structures (increase # of L31S outlet structures by 1)

    S194, S196 and S176 are operated at higher stages so pumps start operating first for FC

    G211N is operated at higher stages (G211 can flow in both directions)
- **Add C111 spreader canal and S-332E pump**
  - **canal22:** Add C500E canal segments
  - **cndta22:** Add C500E canal

    Add S332E pump as C111E outlet structure (into C500E)

    S18C is operated at higher stages so both S332E and S18C operate simultaneously for FC

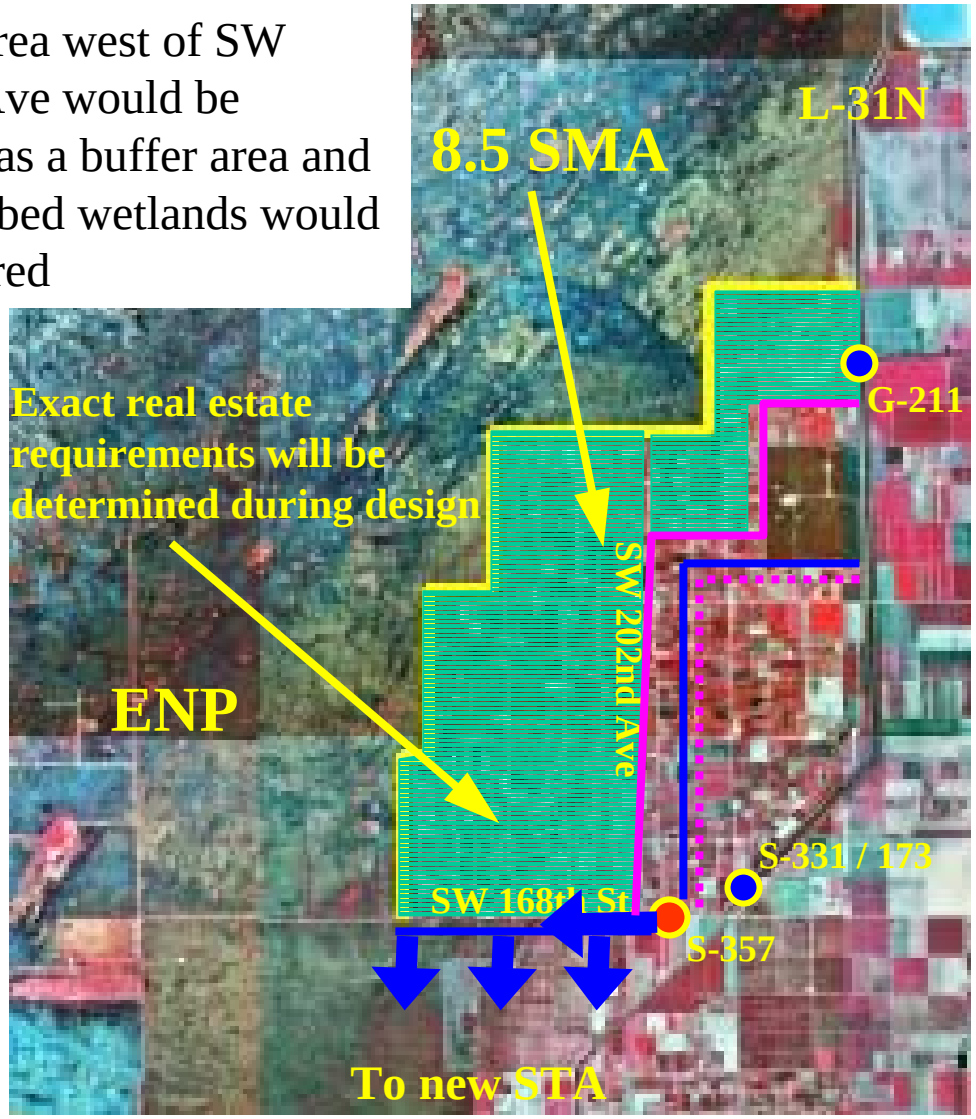
    Add 3.3’ C111E constraint to flows through COMBQ

Input changes to add C-111 Project (as in RESTUDY 2050 Base) Cont….

- **Remove C-110/C-109 canals (C-109 not modeled in 2x2):**
  - **canal22:** Remove C110
  - **cndta22:** Remove C110
  - **statdta:** Change CBN from 0 to 55 to prevent overland flow with the South Dade Area and keep the Model Lands and Southern Glades hydrated.

Modifications to MWD

Note: Area west of SW 202nd Ave would be utilized as a buffer area and undisturbed wetlands would be restored



North

LEGEND

- Project Boundary
- Proposed Major Levee
- Proposed Minor Levee
- Proposed seepage canal
- Proposed Buy-out area
- Existing Structure
- Proposed Structure

Note: S357A discharges into spreader canal south of 168th St into C-111 project buffer/STA

Not To Scale

FLOOD PROTECTION PLAN

U.S. Army Corps of Engineers
Jacksonville District

8.5 SMA - Alt # 6

Raise SW 202nd Ave and use Buy-out Area as Buffer

Restudy Modifications to MWD

Geographic Region: South Dade County

Component Title: Modification to South Dade in Southern Portion of L-31N and C-111 (same as Alternatives 4 and 5)

Purpose: To improve deliveries to Everglades National Park and decrease potential flood risk in the Lower East Coast service area.

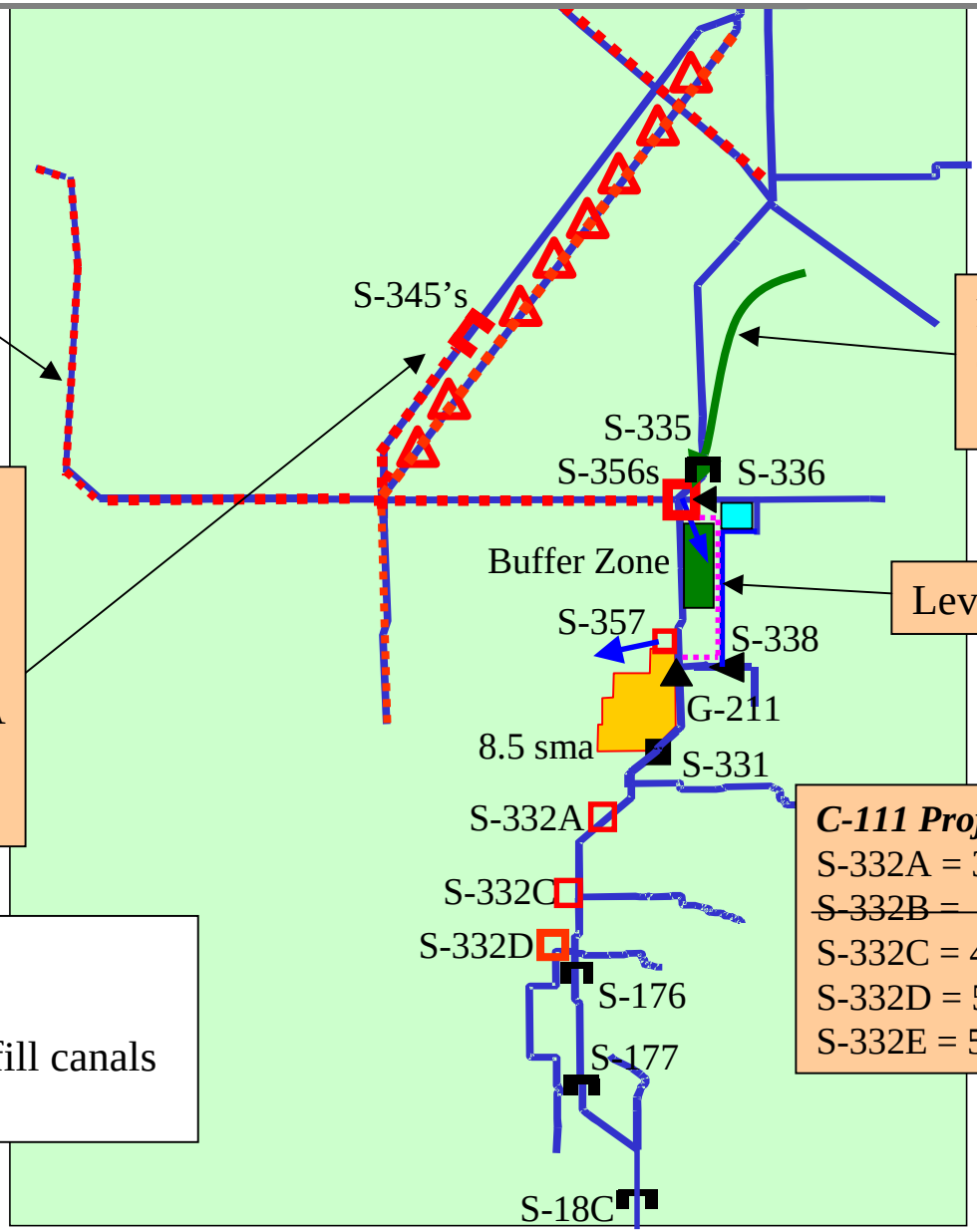
Operation: Modify C-111 Canal operations.

Design:
S-332D at 500 cfs
Remove S-332B
Add 100 cfs to S-332C (keep total of S-332 A-D < 1200 cfs)
Remove S-332 pump station
Remove S-332D Tieback canal which provides flow from C-111 to S-332.

Location: South Dade Conveyance System
Counties: Miami-Dade

Assumptions and related considerations:
1) Will not cause adverse impacts to ENP and South Dade Agricultural Lands.
2) This component is dependent on Component FF.

Restudy Modifications to MWD



Degrade levees, fill canals and remove structures

Releases from Central Lake Belt Storage to ENP

- L-67C levee degraded and canal filled.
- 8 passive weirs across L-67A levee.
- Lower portion of L-67A canal filled.
- S-345s relocated south.

Levee Seepage Barrier

C-111 Project

S-332A = 300 cfs
~~S-332B = 400 cfs~~
S-332C = 400 cfs
S-332D = 500 cfs
S-332E = ~~50 cfs~~ 500 cfs

Proposed

Spillways
Degrade levee and fill canals
pump stations

C-111 Spreader

Component Title: C-111N Spreader Canal (same as Alternative 5) – SEE COMPONENT MAP 13

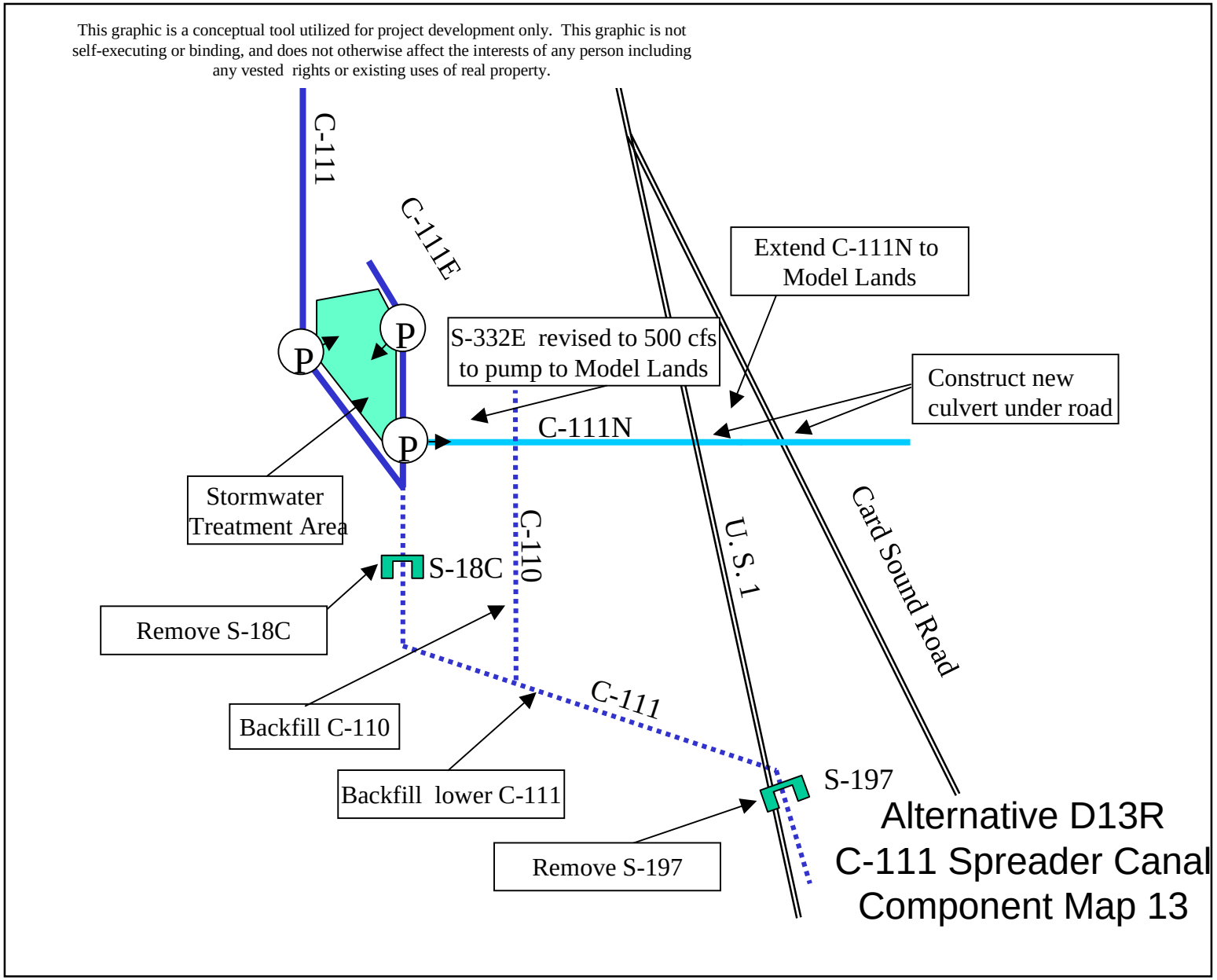
Purpose: To reduce wet season flows in C-111, improve deliveries to Model Lands and Southern Glades and decrease potential flood risk in the lower south Dade area.

Operation: Water is pumped from C-111 and C-111E into a Stormwater Treatment Area (STA) prior to pumping through S-332E into C-111N to Southern Glades and Model Lands. S-197 and S-18C are removed and C-111 is backfilled.

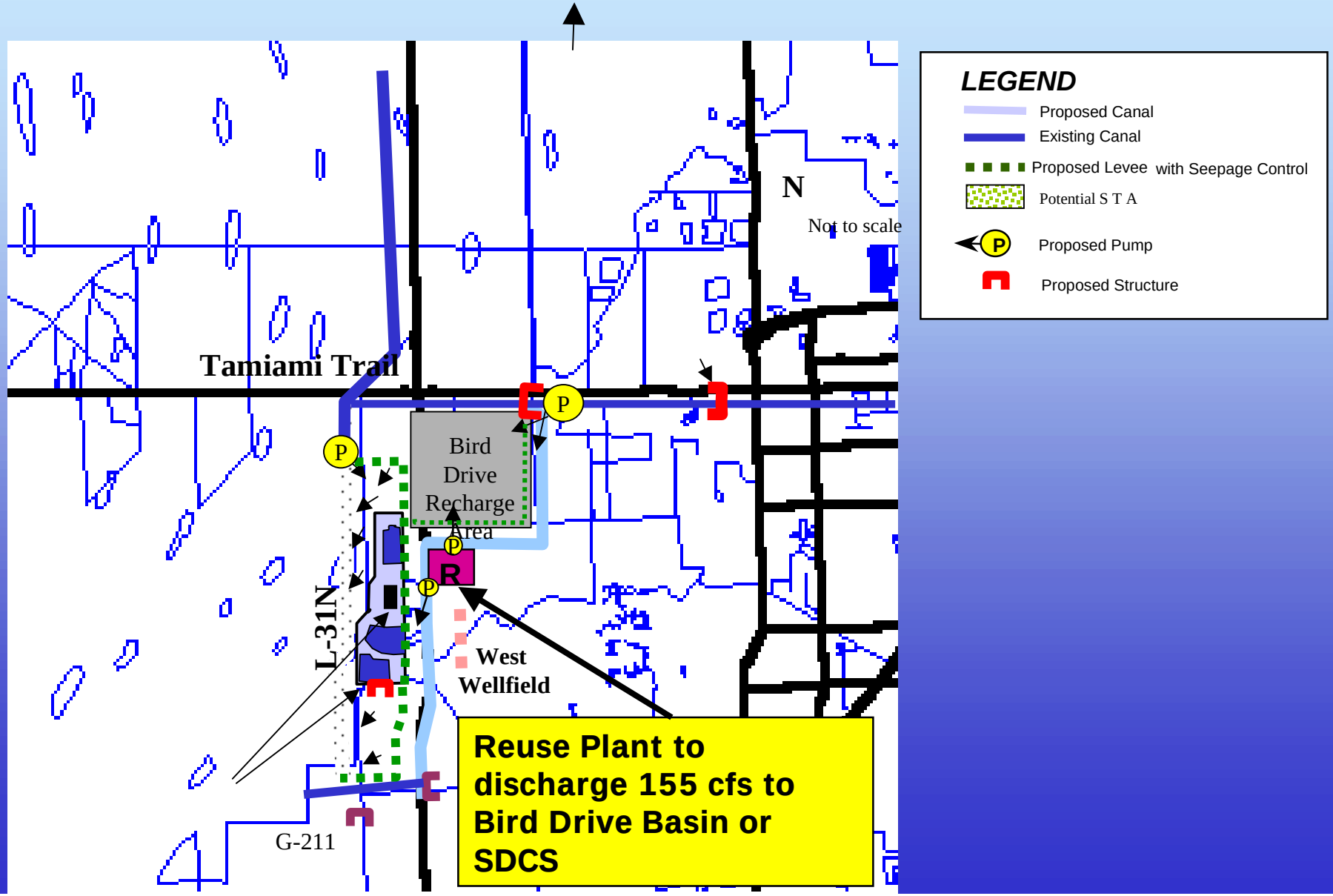
Design:

Increase S-332E to 500 cfs from 50 cfs (pump when available)
Relocate C-111N to SW theoretical 440th street (approximately 1 section north)
Culvert under US 1
Culvert under Card Sound Road
Canal through triangle area of Model Lands, east of Card Sound Road
Fill in C-111 south of confluence with C-111N to S-197
Remove levees and access roads
Completely backfill C-110
Create STA in triangle land between C-111 and C-111E to clean water prior to putting in Model Lands

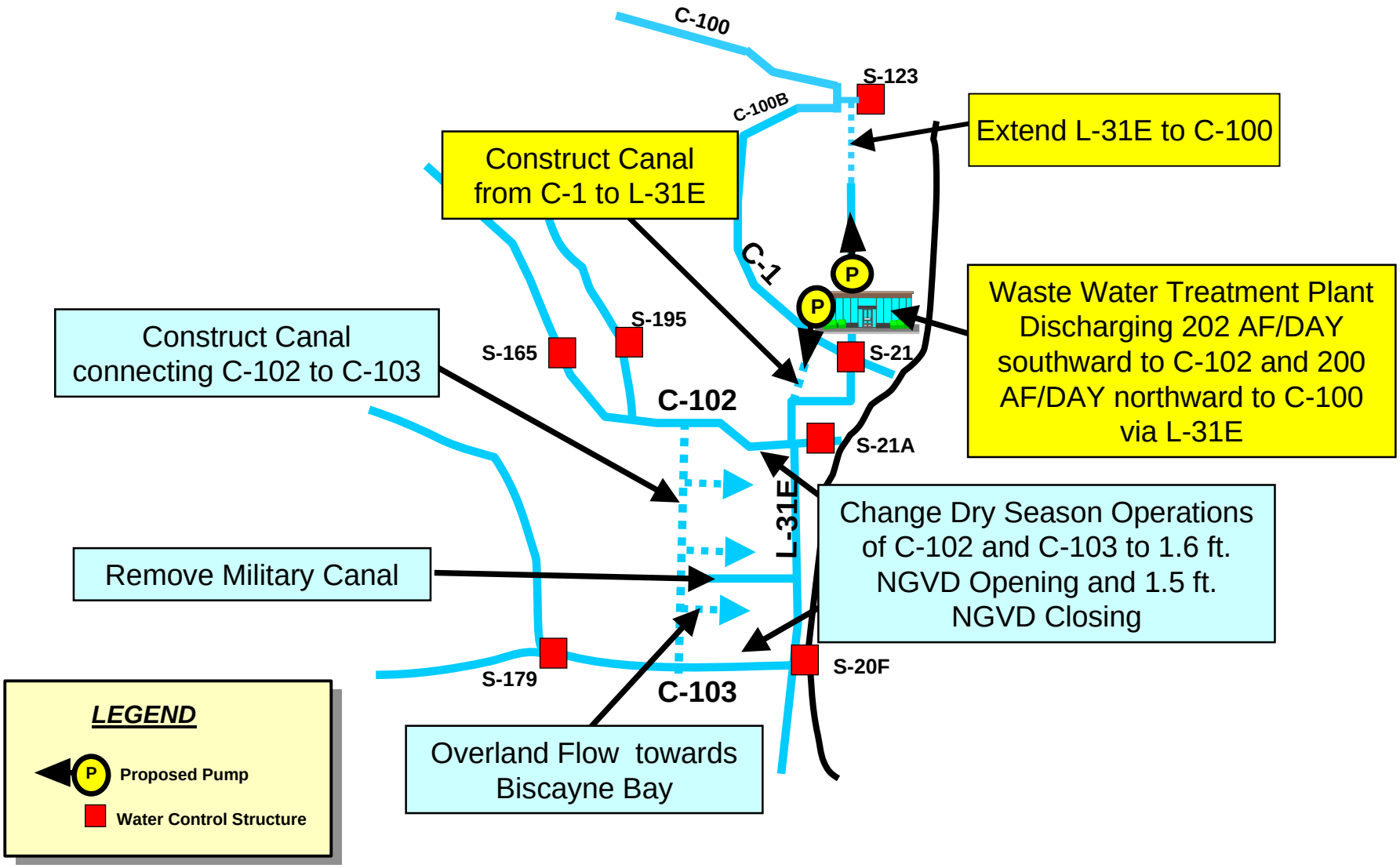
C-111 Spreader



West Miami-Dade Reuse

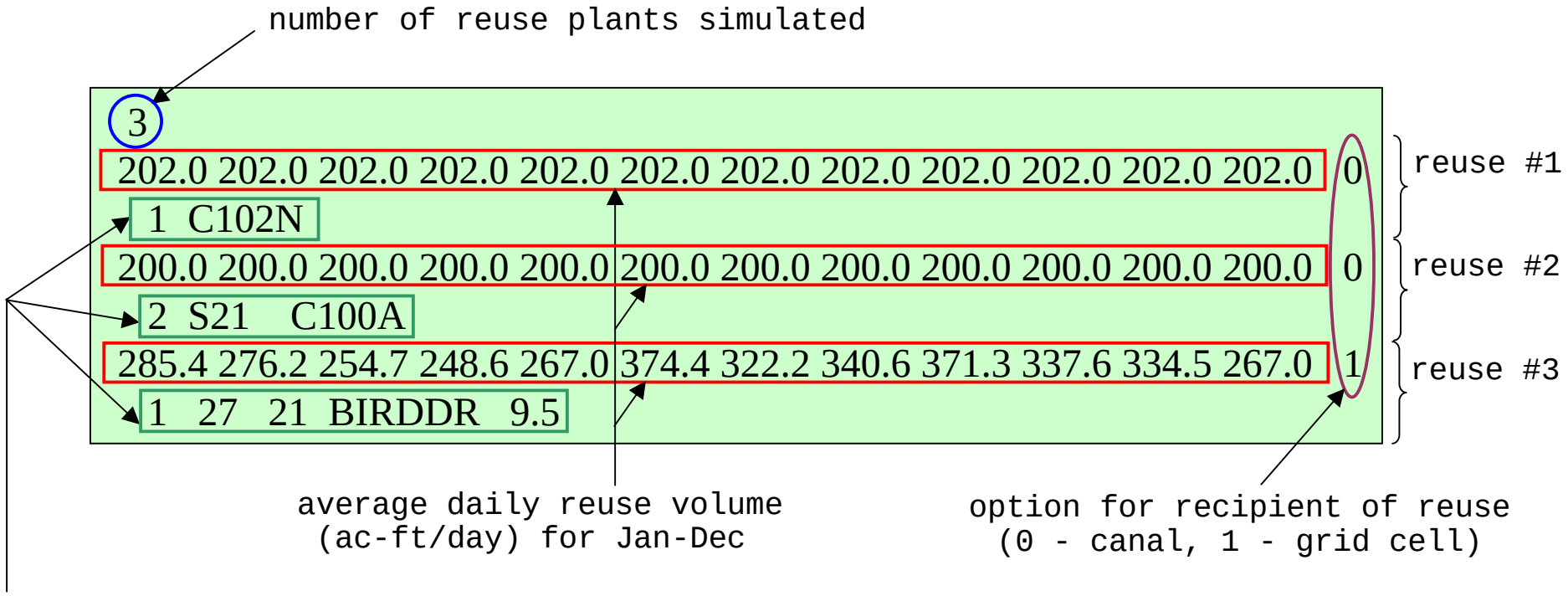


South Miami-Dade Reuse



Sample Input for Reuse Components

(from ECP Future w/ Project **lecdef** input file - under "Service Areas - Water Supply")



- if option for recipient of reuse is 0 (canal(s)) :
  number of canals receiving reuse ;
  name of canal(s) ;
- if option for recipient of reuse is 1 (grid cell(s)) :
  number of grid cells receiving reuse ;
  column & row grid cell location(s) ;
  name of destination reservoir(s) ;
  max stage in reservoir(s) allowed for routing of reuse water

Sample Input for Reuse Components

ECP Future w/o Project **lecdef** input file

```
 0
```

ECP Future w/ Project **lecdef** input file

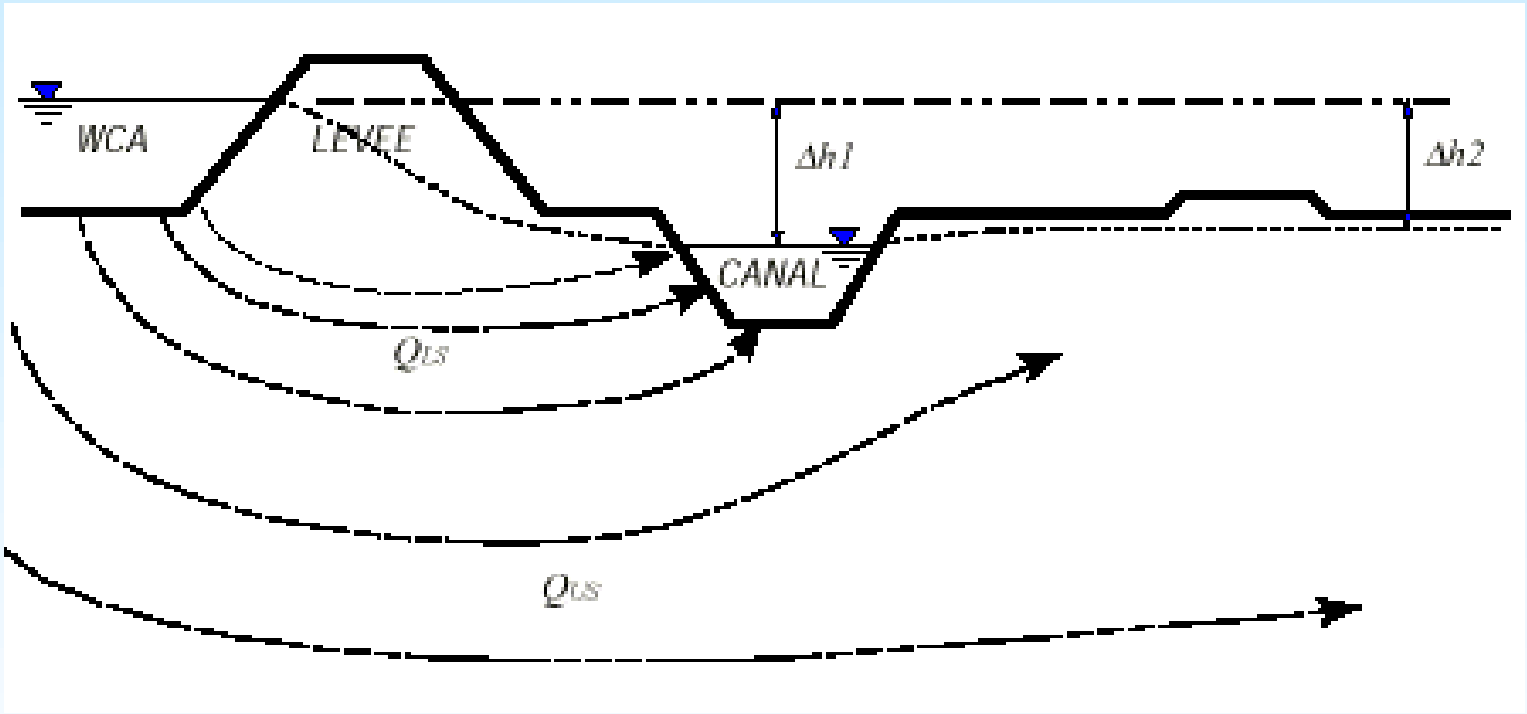
```
 3
202.0 202.0 202.0 202.0 202.0 202.0 202.0 202.0 202.0 202.0 202.0 202.0   0
  1  C102N
200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0   0
  2  S21    C100A
285.4 276.2 254.7 248.6 267.0 374.4 322.2 340.6 371.3 337.6 334.5 267.0   1
  1   27   21  BIRDDR   9.5
```

Source Code for Reading Input for Reuse Components

(from **gen_model_def_param.F** v5.0beta)

```
c
c   input data for Water Reuse
c
      read (2,*) no_of_reuse_plnts
       do i = 1,no_of_reuse_plnts
        read (2,*) (avg_daily_reuse_vol(i,j),j=1,12),iopt_rec_reuse(i)
        if (iopt_rec_reuse(i) .eq. 0) then
         read (2,'(i5,5(2x,A5))')no_canals_reuse(i)
     $         ,(canal_reuse_names(k),k=1,no_canals_reuse(i))
         do k=1,no_canals_reuse(i)
           call match(canal_reuse_names(k),1,5,cnm,nch+1,5,imatch)
           if (imatch .eq. 0) then
             write(*,1010) canal_reuse_names(k)
 1010  format(2(/),'UNRECOGNIZED  CANAL NAME FOR REUSE',2x,A5)
             stop
           endif
           icanal_reuse_indx(i,k) = imatch
         enddo
        else
         read (2,'(5(3i5,2x,a6,2x,F4.1))') no_grid_cells_reuse(k)
     $        ,(icol_reuse(k),irow_reuse(k),resname_reuse(i,k)
     $        ,rmax_stage_reuse(i,k),k=1,no_grid_cells_reuse(i))
         do k=1,no_grid_cells_reuse(i)
           node_reuse(i,k) = icol_reuse(k) - minx(irow_reuse(k))
     $          + 1 + isum(irow_reuse(k))
         enddo
        endif
       enddo
```

Levee Seepage and Groundwater flow



Total groundwater flow beneath a levee (Q_S)is the sum of regional groundwater flow or underseepage (Q_{US}) and levee seepage (Q_{LS})

$$Q_S = Q_{US} + Q_{LS}$$

Levee Seepage

Determined empirically using SEEP2D

$$Q_{LS} = \beta_0 + \beta_1 \Delta h_1 + \beta_2 \Delta h_2$$

where Q_{LS} is the levee seepage in cfs/mile,
β_0, β_1 and β_2 are levee seepage coefficients,
Δh_1 is the head gradient from levee to levee borrow canal
Δh_2 is the regional head gradient across the levee

Different levels of levee seepage management can be simulated in the SFWMM by reducing Q_{LS} by a fraction f, of the levee seepage determined by equation (1)

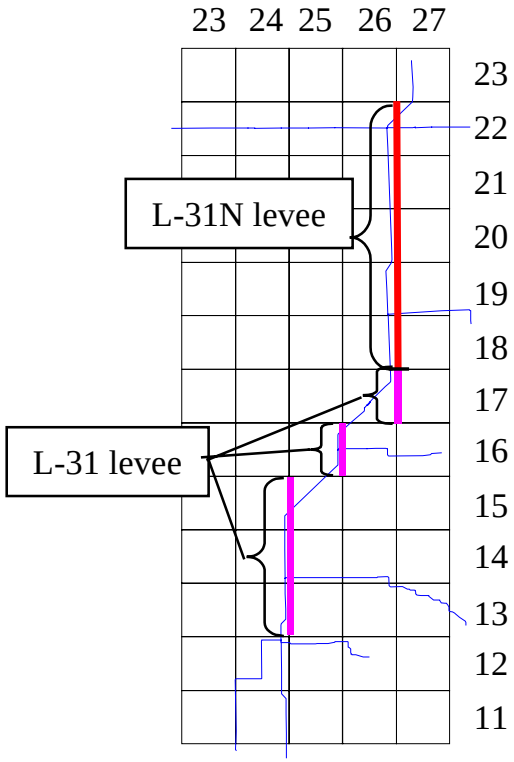
Groundwater Flow

Cell to cell groundwater flow is determined by solution of the regional groundwater flow equations

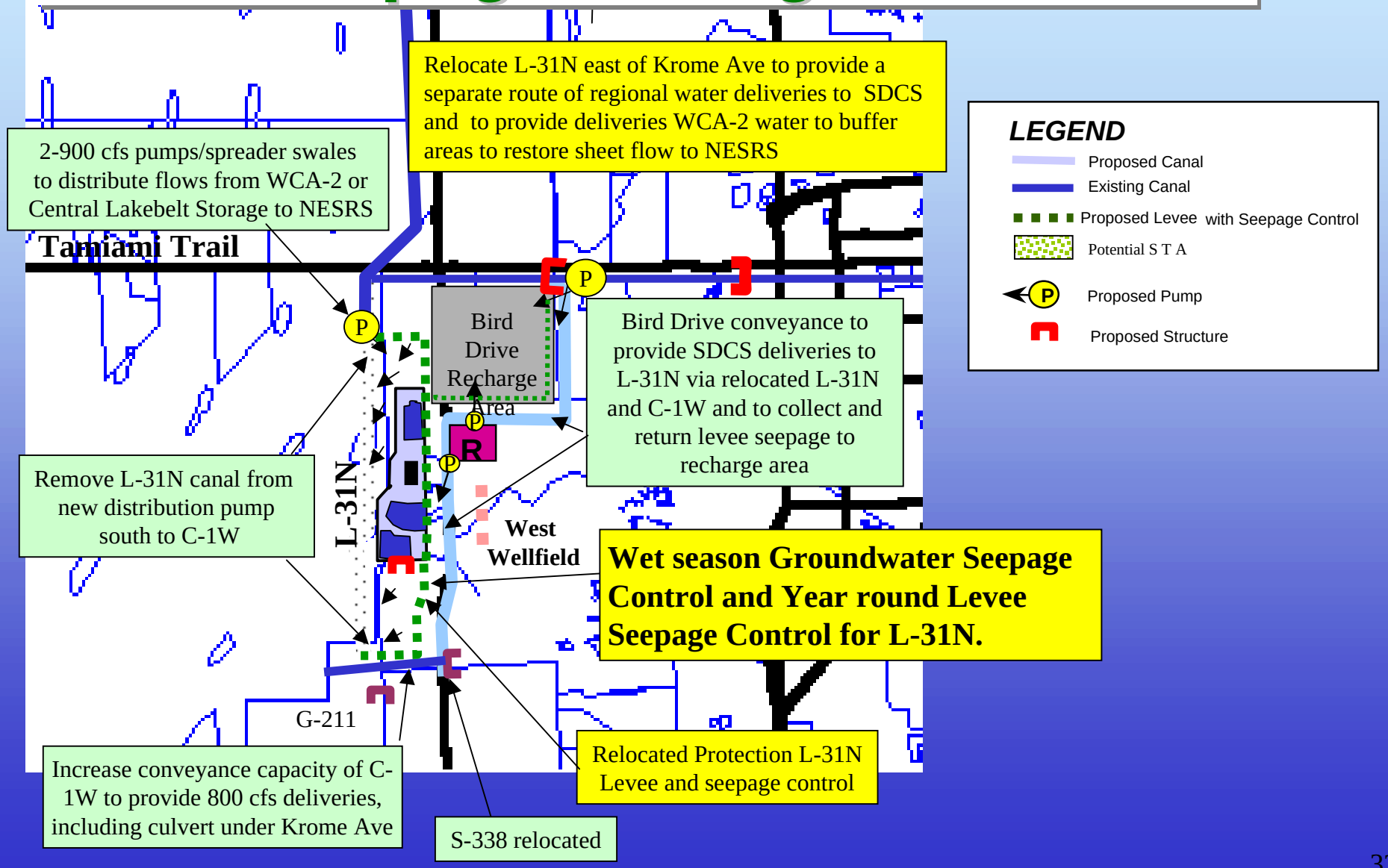
General levee seepage constants

Levee	β_1	β_2	β_0	f	Max (cfs/mi/ft)
L-31N	79.0	-77.9	1.0	1.0	234
L31	94.0	-77.9	2	0.65	234

Typical



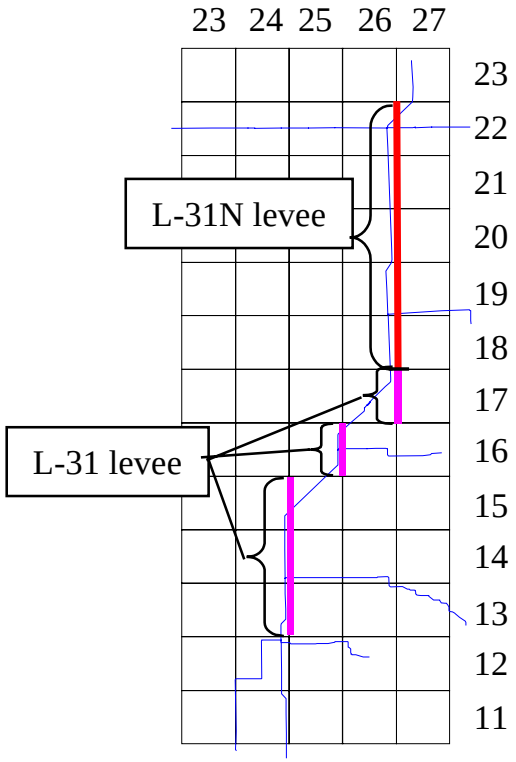
L-31N Relocation and Levee Seepage Management



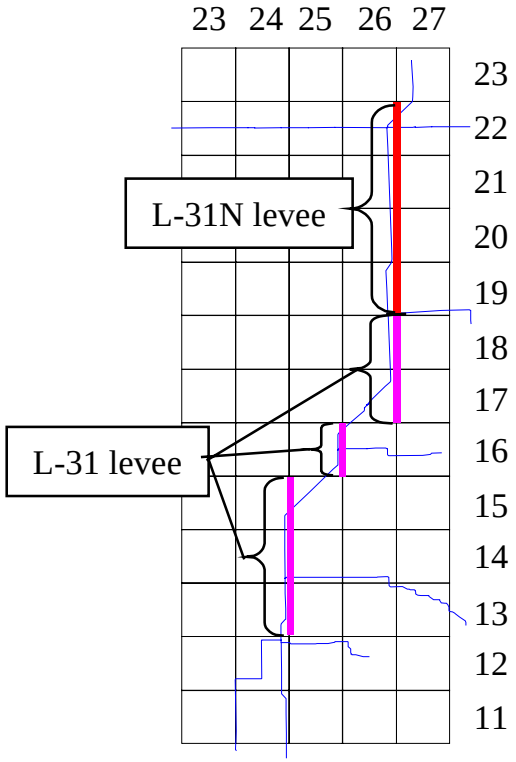
D13R levee seepage constants

Levee	β_1	β_2	β_0	f	Max (cfs/mi/ft)
L-31N	79.0	-77.9	1.0	~~1.0~~ 0.0	234
L31	94.0	-77.9	2	0.65	234

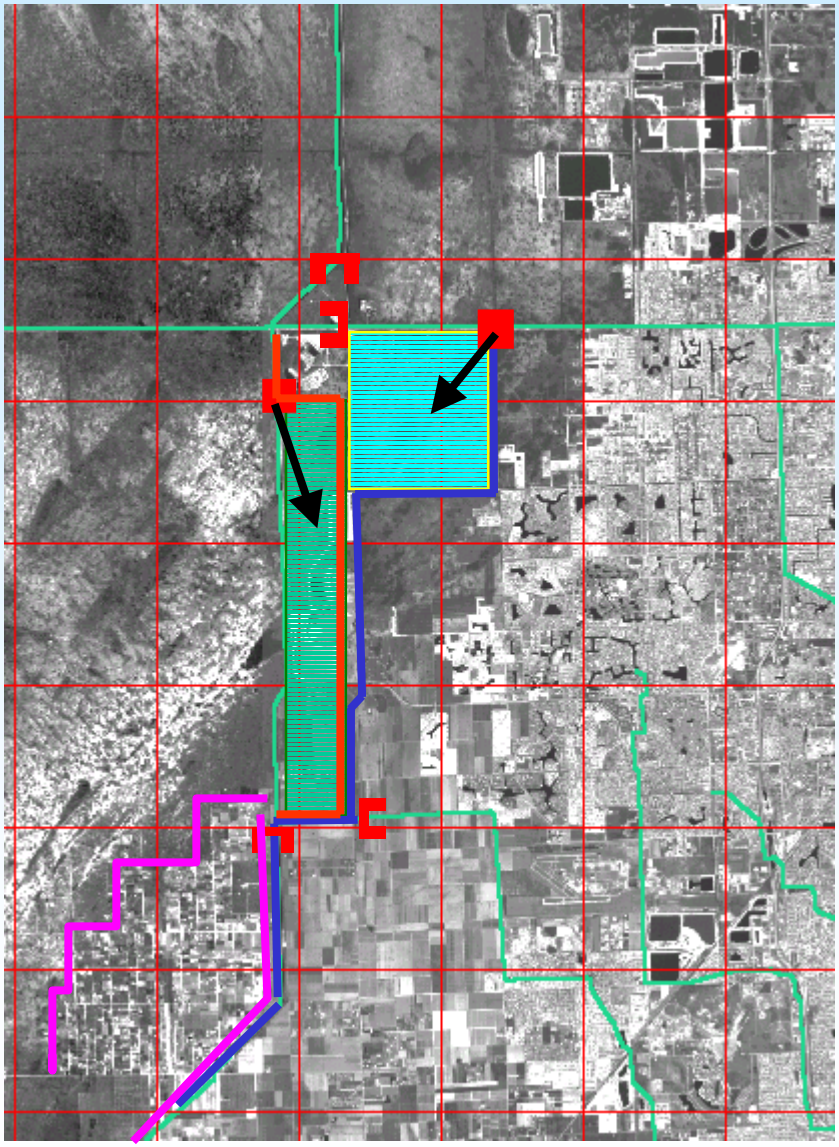
Typical



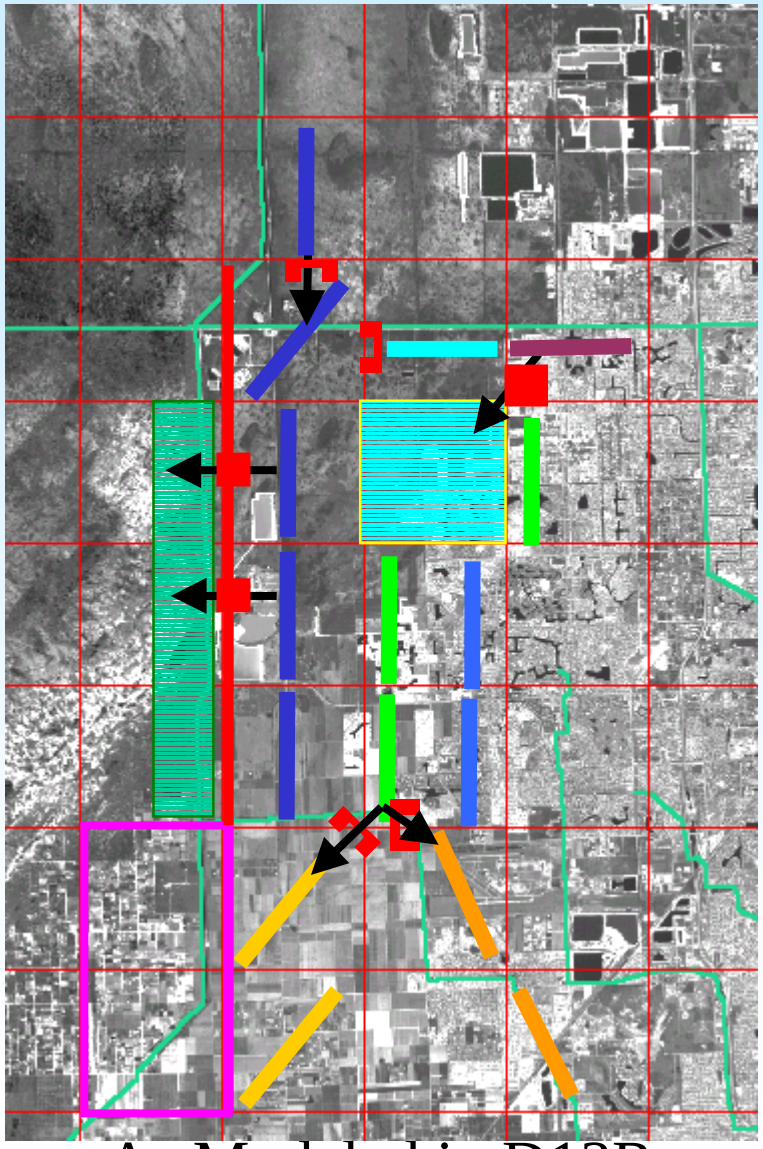
D13R



L-31N Buffer and Bird Drive Recharge Area



Conceptual Design



As Modeled in D13R SFWMMv3.5

D13R grid

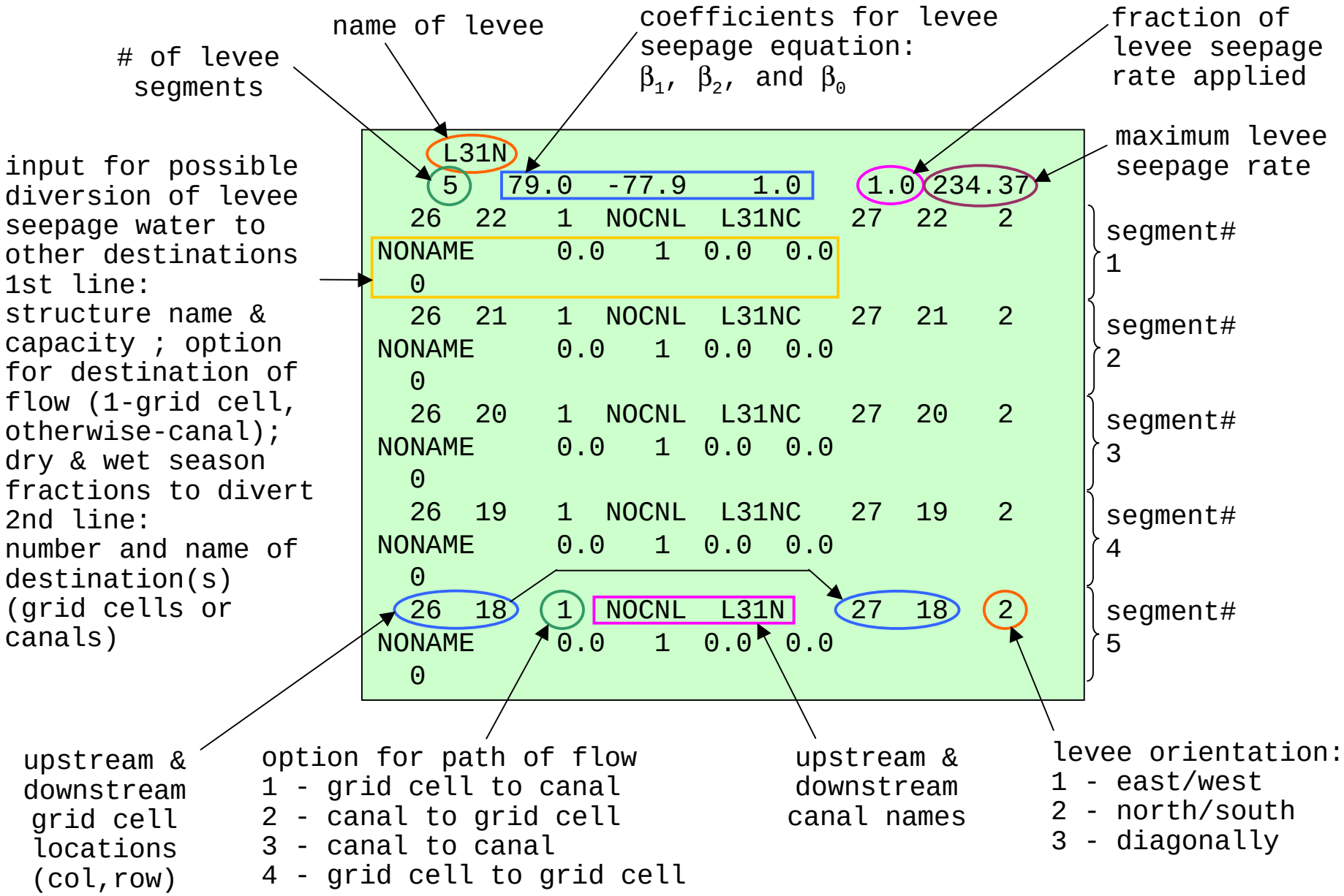
Passive Levee Seepage Management

- 2010 & 2015 Case Studies, initial simulations had same seepage management configuration as D13R
- Resulted in serious reduction of flows to Biscayne Bay, particularly Central Bay. Why?
- Remedy: no seasonal cutoff of groundwater flow under L-31N levee & no cutoff of levee seepage.
- Also, flow to Biscayne Bay enhanced with S336B and S338B which linked L-31N to C-4 & C-1W to pass water that seeped into L-31N on to Biscayne Bay

2010CS grid

Sample Input for L-31N (North of G-211) Levee Seepage Components

(from ECP Future w/o Project **levee_spg_input.dat** input file)



Sample Input for L-31N (North of G-211) Levee Seepage Components

ECP Future w/o Project **levee_spg_input.dat** input file

```
    L31N
    5   79.0  -77.9    1.0    1.0 234.37
  26  22   1  NOCNL  L31NC   27  22   2
NONAME     0.0   1  0.0  0.0
  0
  26  21   1  NOCNL  L31NC   27  21   2
NONAME     0.0   1  0.0  0.0
  0
  26  20   1  NOCNL  L31NC   27  20   2
NONAME     0.0   1  0.0  0.0
  0
  26  19   1  NOCNL  L31NC   27  19   2
NONAME     0.0   1  0.0  0.0
  0
  26  18   1  NOCNL  L31N    27  18   2
NONAME     0.0   1  0.0  0.0
  0
  L31
    5   94.0  -77.9    2.0   0.65 234.37
  26  17   1  NOCNL  L31N    27  17   2
NONAME     0.0   1  0.0  0.0
  0
  25  16   1  NOCNL  L31S    26  16   2
NONAME     0.0   1  0.0  0.0
  0
  24  15   1  NOCNL  L31S    25  15   2
NONAME     0.0   1  0.0  0.0
  0
  24  14   1  NOCNL  L31S    25  14   2
NONAME     0.0   1  0.0  0.0
  0
  24  13   1  NOCNL  L31S    25  13   2
NONAME     0.0   1  0.0  0.0
  0
```

```
    L31N
    4    0.0    0.0    0.0    1.0   0.00
  26  22   1  NOCNL  L31NC   27  22   2
NONAME     0.0   1  0.0  0.0
  0
  26  21   4  NOCNL  NOCNL   27  21   2
NONAME     0.0   1  0.0  0.0
  0
  26  20   1  NOCNL  CROMA   27  20   2
NONAME     0.0   1  0.0  0.0
  0
  26  19   1  NOCNL  CROMA   27  19   2
NONAME     0.0   1  0.0  0.0
  0
  L31
    6   94.0  -77.9    2.0   0.65 234.37
  26  18   1  NOCNL  L31N    27  18   2
NONAME     0.0   1  0.0  0.0
  0   26  18
  26  17   1  NOCNL  L31N    27  17   2
NONAME     0.0   1  0.0  0.0
  0   26  17
  25  16   1  NOCNL  L31S    26  16   2
NONAME     0.0   1  0.0  0.0
  0   25  16
  24  15   1  NOCNL  L31S    25  15   2
NONAME     0.0   1  0.0  0.0
  0   24  15
  24  14   1  NOCNL  L31S    25  14   2
NONAME     0.0   1  0.0  0.0
  0   24  14
  24  13   1  NOCNL  L31S    25  13   2
NONAME     0.0   1  0.0  0.0
  0   24  13
```

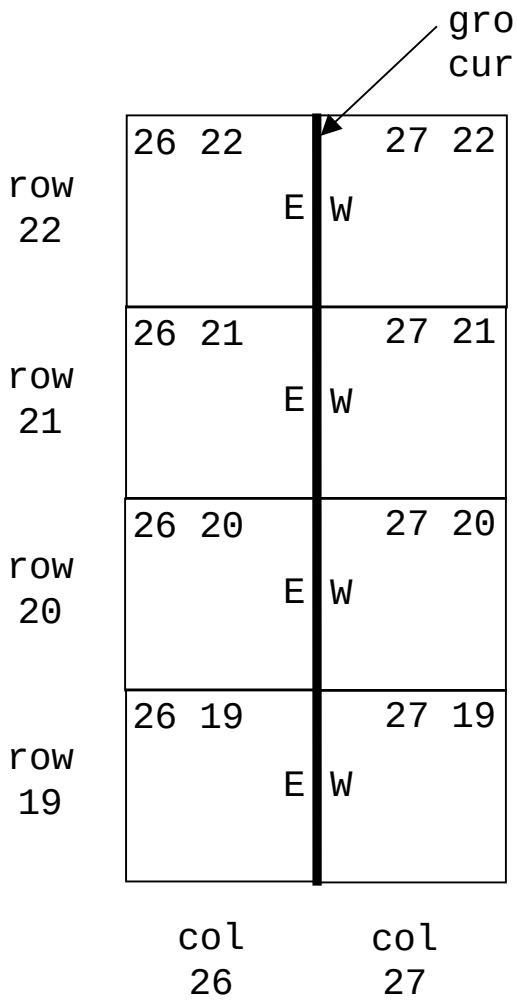
ECP Future w Project **levee_spg_input.dat** input file

Sample Output for Monthly Levee Seepage
(from ECP Future w/o Project mthly_levee_spg.dat output file)

```
NO OF PRS:    85
FROM NODE: 30,53  ...   26,22 26,21 26,20 26,19 26,18  ...
TO NODE  : 31,53        27,22 27,21 27,20 27,19 27,18
   1965  1   88.        5481.   39.    2.    0.  261.
   1965  2   78.       14858. 1093. 1207.   20.  918.
   1965  3   30.       18805.  327.  334.   29.  826.
   1965  4  -66.        6547.    0.    2.    0.   98.
   1965  5  -70.        4610.    0.    0.    0.    0.
   1965  6  -79.        2515.  144.   68.    0.   23.
   1965  7  -78.        3020.  167.  419.   15.  355.
   1965  8    0.        3141.   38.    0.    2.  471.
   1965  9   51.        4683.  347.  676.   36. 1374.
   1965 10   83.       13831. 2516. 2504. 1472. 3344.
   1965 11   88.       19581. 3783. 2865. 1767. 2412.
   1965 12   91.       20420. 1274.  126.    1.  814.
   1966  1   91.       19724.  951.  667.   19. 1441.
   1966  2   73.       10420.  130.  317.    0.  505.
   1966  3   59.        5322.  138.  244.    0.  551.
   1966  4    7.        5293.  234.  365.    0.  733.
   1966  5  -64.        6487.  666.  947.  318. 1001.
   1966  6  -76.       12044. 3247. 3653. 2150. 3665.
   .
   .
   .                                        values in ac-ft
```

Sample Input for L-31N (North of G-211) Curtain Wall Components

(from ECP Future w/ Project **levee_spg_input.dat** input file - at end)




```
segment
#1
    26  22
    E O O O
01 11 11 11
segment
#2
    27  22
    O W O O
11 01 11 11
segment
#3
    26  21
    E O O O
01 11 11 11
segment
#4
    27  21
    O W O O
11 01 11 11
segment
#5
    26  20
    E O O O
01 11 11 11
segment
#6
    27  20
    O W O O
11 01 11 11
segment
#7
    26  19
    E O O O
01 11 11 11
segment
#8
    27  19
    O W O O
11 01 11 11
```

grid cell location (col,row)

grid cell face(s) to apply curtain wall: E, W, N, S (O implies no curtain wall)

for each face (E, W, N, S): option for dry season and/or wet season operation:
0 - not operational
1 - operational

Sample Input for L-31N (North of G-211) Curtain Wall Components

ECP Future w/ Project
levee_spg_input.dat input file

```
 26  22
 E 0 0 0
01 11 11 11
 27  22
 0 W 0 0
11 01 11 11
 26  21
 E 0 0 0
01 11 11 11
 27  21
 0 W 0 0
11 01 11 11
 26  20
 E 0 0 0
01 11 11 11
 27  20
 0 W 0 0
11 01 11 11
 26  19
 E 0 0 0
01 11 11 11
 27  19
 0 W 0 0
11 01 11 11
```

LEC 2020 w/ Project
levee_spg_input.dat input file

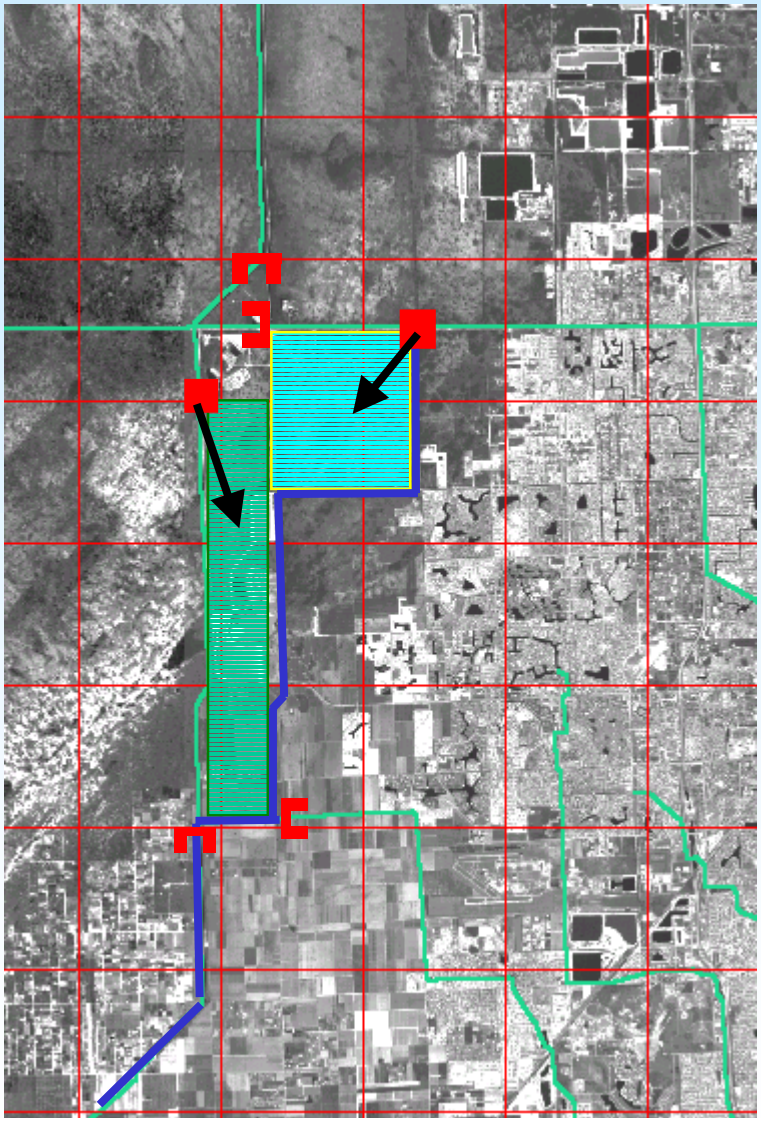
```
 26  22
 E 0 0 0
00 11 11 11
 27  22
 0 W 0 0
11 00 11 11
 26  21
 E 0 0 0
00 11 11 11
 27  21
 0 W 0 0
11 00 11 11
 26  20
 E 0 0 0
00 11 11 11
 27  20
 0 W 0 0
11 00 11 11
 26  19
 E 0 0 0
00 11 11 11
 27  19
 0 W 0 0
11 00 11 11
```

Source Code for Reading Input for Levee Seepage & Curtain Wall Components

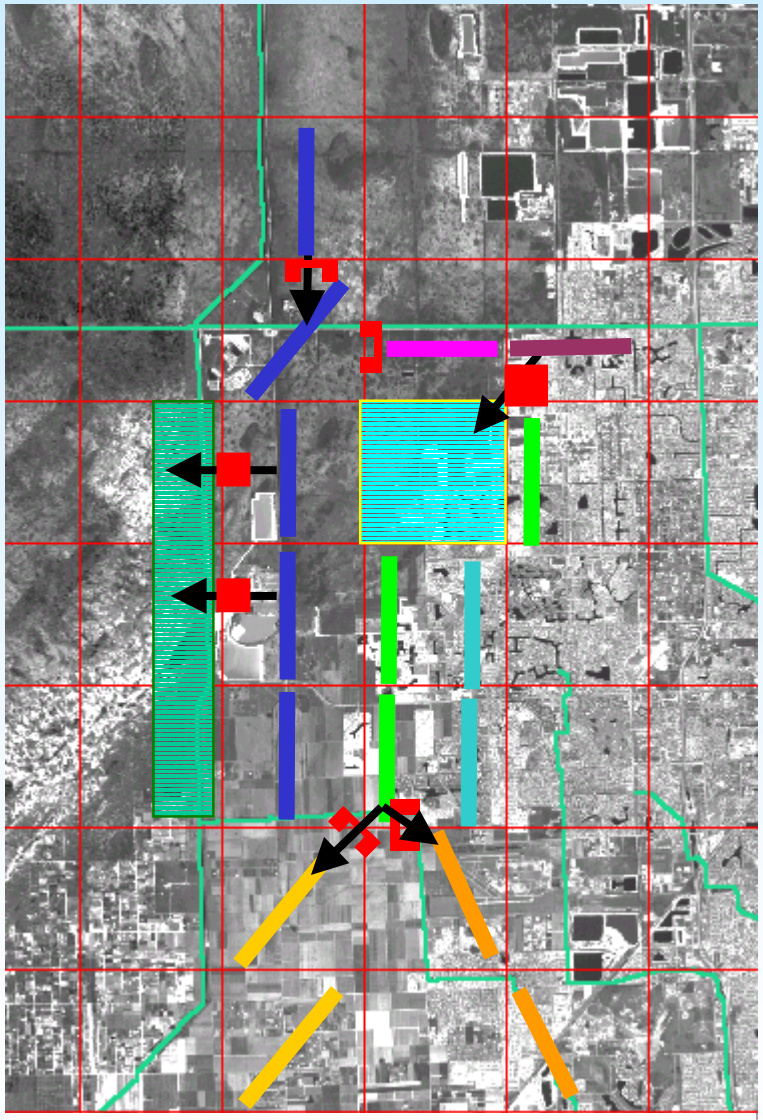
(from **cnldata.F** v5.0beta)

```
      DO 260 K = 1,NLEVS
        READ  (104,'(5x,A5)') LVNAME(K)
        .
        READ (104,'(I5,5F7.2)') LVNODES(KK),SRATE(KK,1),SRATE(KK,2) ,
     +   SRATE(KK,3),srate_frac(KK),rate_limit(KK)
        DO 250 IL = 1,LVNODES(KK)
           L = L + 1
           READ (104,240) (LVSP(L,IK),IK = 1,3), borrow_cnl_name_upstrm ,
     +        borrow_cnl_name_dnstrm,(LVSP(L,IK),IK = 6,8)
           .
           READ (104,*) lvseep_divers_str_name(L),lvseep_pump_cap(l) ,
     +      opt_dest_lvseep(l),(frac_seep_divers(l,i),i=1,2)
           IF (opt_dest_lvseep(l) .EQ. 1) THEN
              READ (104,*) no_dest_lvseep(l),(icol_dest_lvseep(i) ,
     +        irow_dest_lvseep(i),i=1,no_dest_lvseep(l))
              .
           ELSE
              READ (104,'(i3,2x,5(A5,2x))') no_dest_lvseep(l) ,
     +        (dest_canal_name_lvseep(i),i=1,no_dest_lvseep(l))
              .
           ENDIF
           .
260   CONTINUE
270   READ (104,'(2I5)',END = 280) ICOL_CW,IROW_CW
      NODE_CW = ICOL_CW - MINX(IROW_CW) +  1+ ISUM(IROW_CW)
      READ (104,'(3X,5(A1,1X))') (BORIENT(NODE_CW,I),I=1,4)
      READ (104,'(2x,4(2i1,1X))') ((icurtw_opt(NODE_CW,I,J),I=1,2) ,J=1,4)
      ICURTAIN(NODE_CW) = 1
      GO TO 270
      .
240   FORMAT(3I4,2x,A5,2x,A5,1x,3i4)
```

Bird Drive Recharge Area

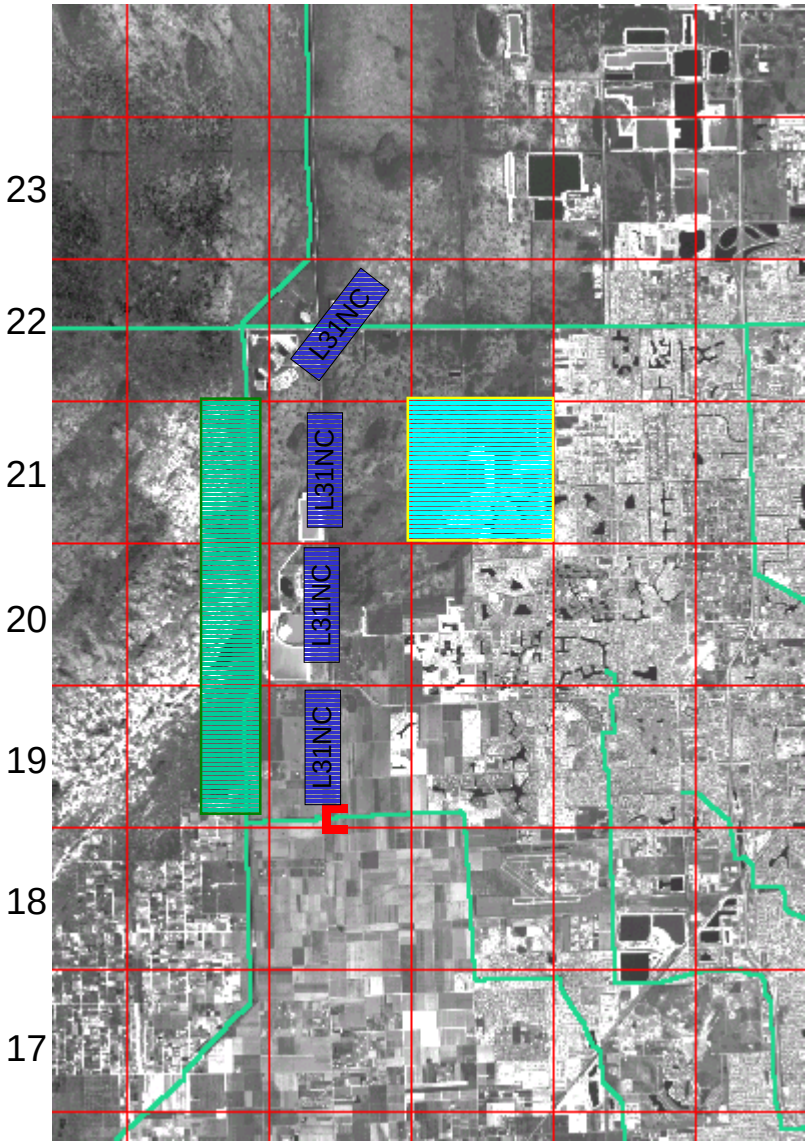


Conceptual Design
L31N and Bird Dr Recharge

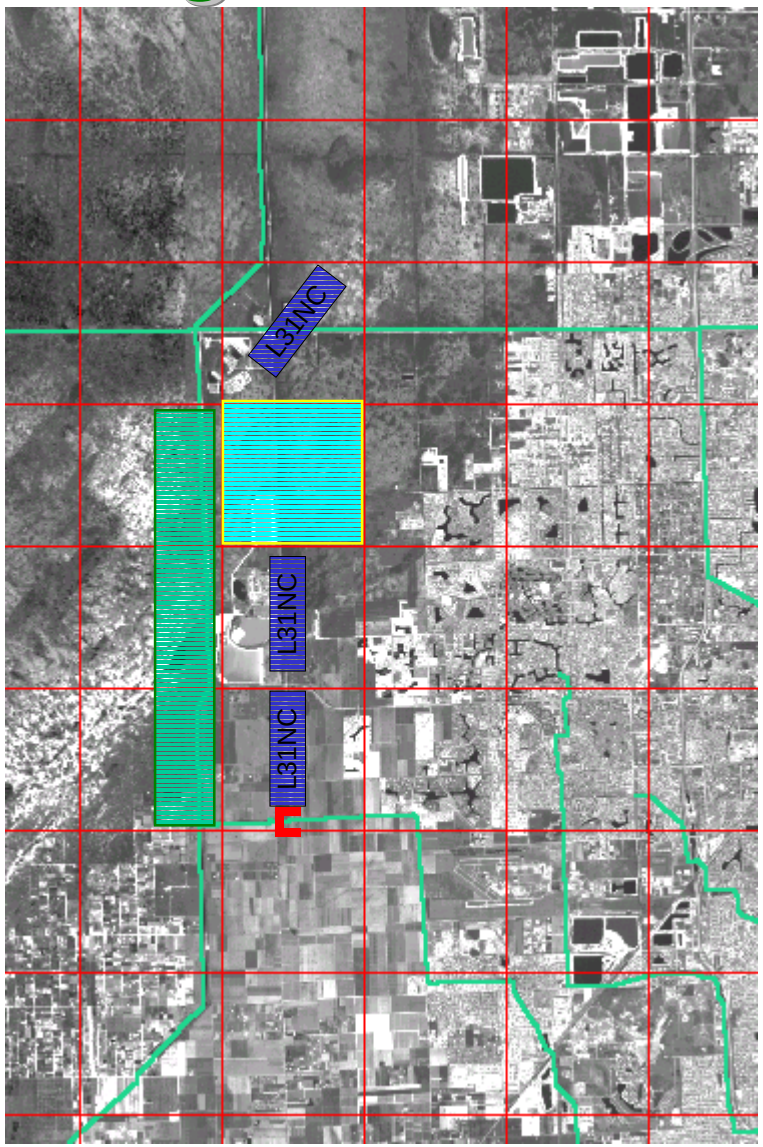


As Modeled in D13R
SFWMMv3.5

Bird Drive Recharge Area

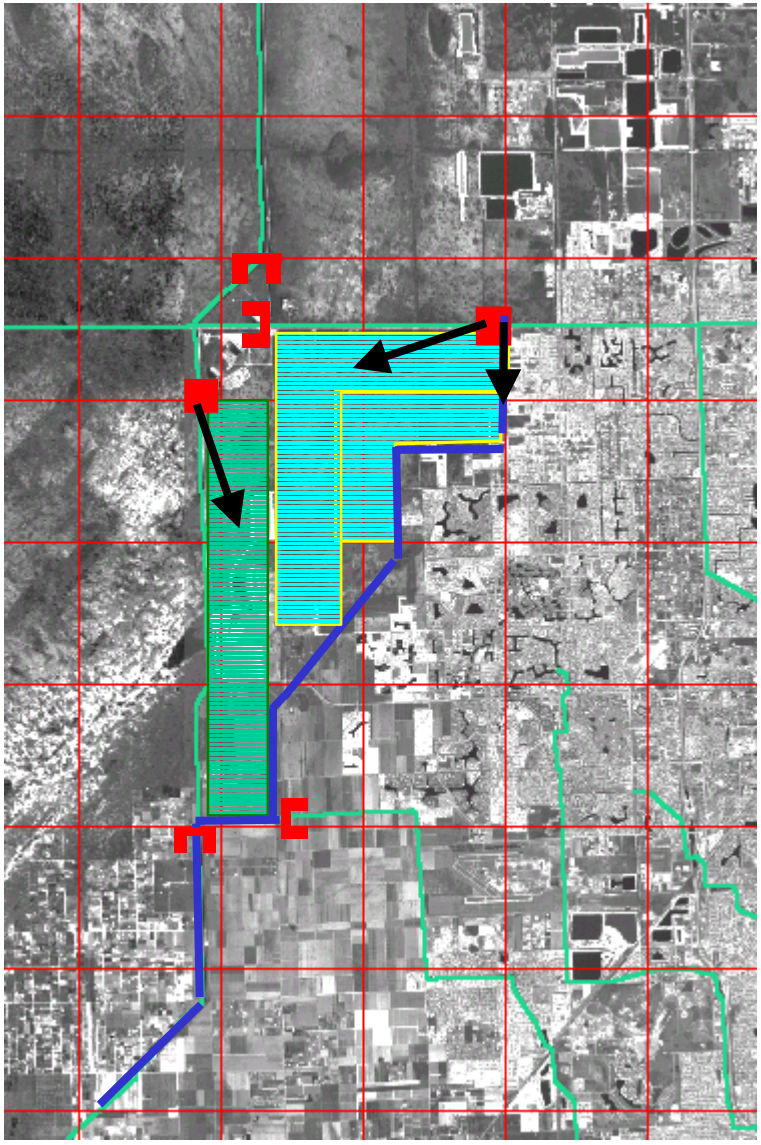


As Modeled in D13R SFWMMv3.5

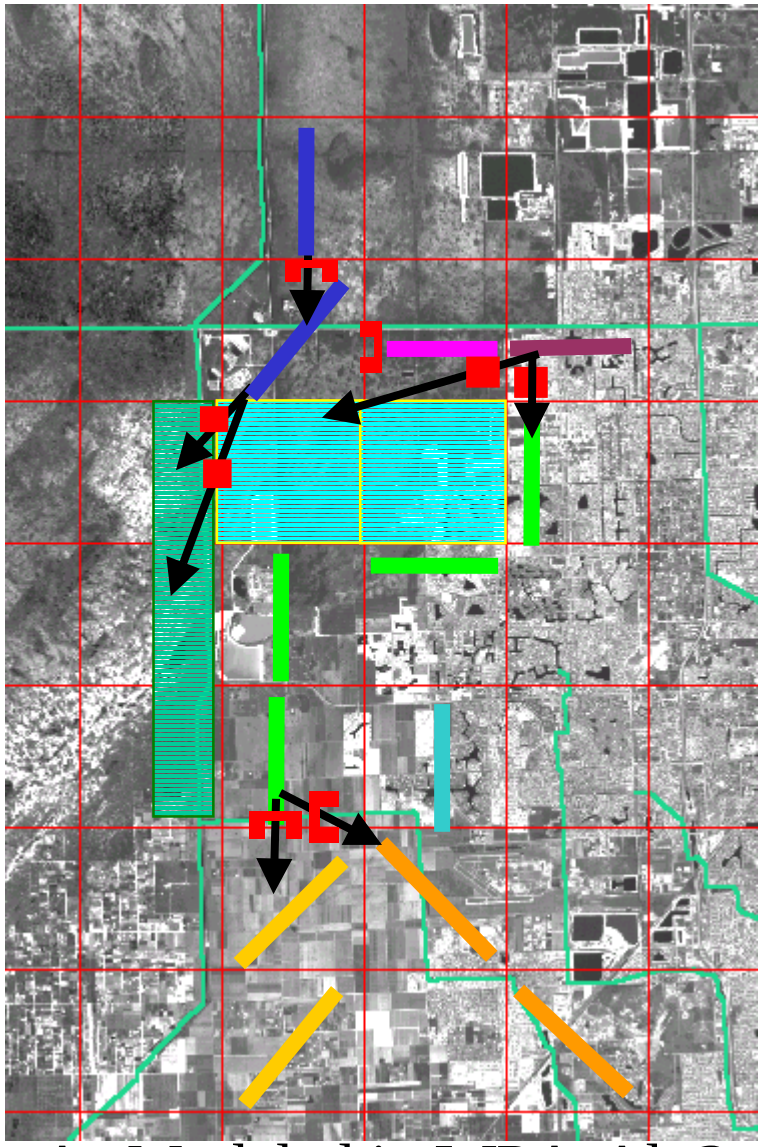


As Modeled in LEC2020 SFWMMv3.7

Bird Drive Recharge Area



Conceptual Design
WPA-Alt 3



As Modeled in WPA-Alt 3
SFWMMv3.5.1