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

- L-31 N Levee Seepage Management
- C-111N Spreader Canal
- West and South Miami-Dade Reuse

- Canal and Structure Modifications
- Reuse
- Seepage Management
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

**Modified Water Deliveries and C-111 Projects**

**Modeling Assumptions**
- 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
**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**

![Image of special CBN codes]
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

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

SPECIAL CBN CODES

[Diagrams of SPECIAL CBN CODES]

EXAMPLE

[Grid diagram with special codes and CBN numbers]
Data: 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
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.
Note: Area west of SW 202nd Ave would be utilized as a buffer area and undisturbed wetlands would be restored.

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

FLOOD PROTECTION PLAN

Not To Scale
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.
**Proposed Spillways**

- Degrade levees, fill canals and remove structures
- 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.

**Releases from Central Lake Belt Storage to ENP**

**Levee Seepage Barrier**

**C-111 Project**

- S-322A = 300 cfs
- S-322B = 400 cfs
- S-322C = 400 cfs
- S-322D = 500 cfs
- S-322E = 50 cfs - 500 cfs
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

This graphic is a conceptual tool utilized for project development only. This graphic is not self-executing or binding, and does not otherwise affect the interests of any person including any vested rights or existing uses of real property.

- Stormwater Treatment Area
- S-332E revised to 500 cfs to pump to Model Lands
- Extend C-111N to Model Lands
- Construct new culvert under road
- Remove S-18C
- Backfill C-110
- Backfill lower C-111
- Remove S-197

Alternative D13R
C-111 Spreader Canal Component Map 13
Reuse Plant to discharge 155 cfs to Bird Drive Basin or SDCS
South Miami-Dade Reuse

Legend:
- P Proposed Pump
- Water Control Structure

Construct Canal from C-1 to L-31E
Extend L-31E to C-100

Construct Canal connecting C-102 to C-103

Remove Military Canal

Waste Water Treatment Plant Discharging 202 AF/DAY southward to C-102 and 200 AF/DAY northward to C-100 via L-31E

Change Dry Season Operations of C-102 and C-103 to 1.6 ft. NGVD Opening and 1.5 ft. NGVD Closing

Overland Flow towards Biscayne Bay
### Sample Input for Reuse Components
(from ECP Future w/ Project **lecdef** input file - under “Service Areas - Water Supply”)

<table>
<thead>
<tr>
<th>Number of Reuse Plants Simulated</th>
<th>Reuse #1</th>
<th>Reuse #2</th>
<th>Reuse #3</th>
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<tbody>
<tr>
<td><strong>3</strong></td>
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<tr>
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<tr>
<td><strong>1 C102N</strong></td>
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<td><strong>200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0</strong></td>
<td>0</td>
<td></td>
<td></td>
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<tr>
<td><strong>2 S21  C100A</strong></td>
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<tr>
<td><strong>285.4 276.2 254.7 248.6 267.0 374.4 322.2 340.6 371.3 337.6 334.5 267.0</strong></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1 27  21  BIRDDR  9.5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **number of reuse plants simulated**
- **average daily reuse volume (ac-ft/day) for Jan-Dec**
- **option for recipient of reuse (0 - canal, 1 - grid cell)**

- 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

<p>| | | | | | | | | | | | |</p>
<table>
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### ECP Future w/ Project `lecdef` input file

<table>
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<th>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</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>C102N</td>
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<tr>
<td>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</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>S21 C100A</td>
</tr>
<tr>
<td>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</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>27 21 BIRDDR 9.5</td>
</tr>
</tbody>
</table>
Source Code for Reading Input for Reuse Components
(from gen_model_def_param.F v5.0beta)

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)
    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)
      endif
      icanal_reuse_indx(i,k) = imatch
    enddo
  endif
  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
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,
\( \beta_0, \beta_1 \) and \( \beta_2 \) are levee seepage coefficients,
\( \Delta h_1 \) is the head gradient from levee to levee borrow canal
\( \Delta h_2 \) 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

<table>
<thead>
<tr>
<th>Levee</th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_0$</th>
<th>$f$</th>
<th>Max (cfs/mi/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-31N</td>
<td>79.0</td>
<td>-77.9</td>
<td>1.0</td>
<td>1.0</td>
<td>234</td>
</tr>
<tr>
<td>L31</td>
<td>94.0</td>
<td>-77.9</td>
<td>2</td>
<td>0.65</td>
<td>234</td>
</tr>
</tbody>
</table>

![Diagram of L-31N and L-31 levees](image_url)
L-31N Relocation and Levee Seepage Management

- 2-900 cfs pumps/spreader swales to distribute flows from WCA-2 or Central Lakebelt Storage to NESRS
- Relocate L-31N east of Krome Ave to provide a separate route of regional water deliveries to SDCS and to provide deliveries WCA-2 water to buffer areas to restore sheet flow to NESRS
- Bird Drive conveyance to provide SDCS deliveries to L-31N via relocated L-31N and C-1W and to collect and return levee seepage to recharge area
- Wet season Groundwater Seepage Control and Year round Levee Seepage Control for L-31N.
- Relocated Protection L-31N Levee and seepage control
- Remove L-31N canal from new distribution pump south to C-1W
- Increase conveyance capacity of C-1W to provide 800 cfs deliveries, including culvert under Krome Ave
- S-338 relocated

LEGEND
- Proposed Canal
- Existing Canal
- Proposed Levee with Seepage Control
- Potential S T A
- Proposed Pump
- Proposed Structure
# D13R levee seepage constants

<table>
<thead>
<tr>
<th>Levee</th>
<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_0$</th>
<th>$f$</th>
<th>Max (cfs/mi/ft)</th>
</tr>
</thead>
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<td>-77.9</td>
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<td>4.0</td>
<td>0.0</td>
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<tr>
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<td>-77.9</td>
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<td>0.65</td>
<td>234</td>
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## Typical

![Typical Diagram](image1)

## D13R

![D13R Diagram](image2)
L-31N Buffer and Bird Drive Recharge Area

Conceptual Design

As Modeled in D13R
SFWMMv3.5
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
Sample Input for L-31N (North of G-211) Levee Seepage Components
(from ECP Future w/o Project levee_spg_input.dat input file)

<table>
<thead>
<tr>
<th># of levee segments</th>
<th>name of levee</th>
<th>coefficients for levee seepage equation: $\beta_1$, $\beta_2$, and $\beta_0$</th>
<th>fraction of levee seepage rate applied</th>
<th>maximum levee seepage rate</th>
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<td>26 22 1</td>
<td>NOCNL L31NC</td>
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<tr>
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<td>26 18 1</td>
<td>NOCNL L31N</td>
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<td></td>
<td>NONAME 0.0</td>
<td>1 0.0 0.0</td>
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</tbody>
</table>

input for possible diversion of levee seepage water to other destinations
1st line: structure name & capacity; option for destination of flow (1-grid cell, otherwise-canal);
dry & wet season fractions to divert
2nd line: number and name of destination(s) (grid cells or canals)

upstream & downstream grid cell locations (col,row)

option for path of flow
1 - grid cell to canal
2 - canal to grid cell
3 - canal to canal
4 - grid cell to grid cell

levee orientation: 1 - east/west
2 - north/south
3 - diagonally
Sample Input for L-31N (North of G-211) Levee Seepage Components

```
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
0
26 21 1 NOCNL L31NC 27 21 2
NONAME  0.0  1.0  0.0  0.0
0
26 20 1 NOCNL L31NC 27 20 2
NONAME  0.0  1.0  0.0  0.0
0
26 19 1 NOCNL L31NC 27 19 2
NONAME  0.0  1.0  0.0  0.0
0
26 18 1 NOCNL L31N 27 18 2
NONAME  0.0  1.0  0.0  0.0
0

L31
  6  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
0
25 16 1 NOCNL L31S 26 16 2
NONAME  0.0  1.0  0.0  0.0
0
24 15 1 NOCNL L31S 25 15 2
NONAME  0.0  1.0  0.0  0.0
0
24 14 1 NOCNL L31S 25 14 2
NONAME  0.0  1.0  0.0  0.0
0
24 13 1 NOCNL L31S 25 13 2
NONAME  0.0  1.0  0.0  0.0
0
```

ECP Future w/o Project levee_spill_input.dat input file

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

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MONTH</th>
<th>Nodes</th>
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<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
<th>Value 5</th>
<th>Value 6</th>
<th>Value 7</th>
<th>Value 8</th>
</tr>
</thead>
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<td>...</td>
<td>26,22</td>
<td>26,21</td>
<td>26,20</td>
<td>26,19</td>
<td>26,18</td>
<td>...</td>
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<td></td>
<td>2</td>
<td>30,53</td>
<td>...</td>
<td>27,22</td>
<td>27,21</td>
<td>27,20</td>
<td>27,19</td>
<td>27,18</td>
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<td>3</td>
<td>30,53</td>
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<td>4</td>
<td>30,53</td>
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</tr>
</tbody>
</table>

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)

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

Grid cell face(s) to apply curtain wall: E, W, N, S
(O implies no curtain wall)
Sample Input for L-31N (North of G-211) Curtain Wall Components

ECP Future w/ Project
levee_spg_input.dat input file

LEC 2020 w/ Project
levee_spg_input.dat input file
Source Code for Reading Input for Levee Seepage & Curtain Wall Components

```fortran
DO 260 K = 1, NLEVS
   READ (104, '(5x,A5)') LVNAME(K)
   DO 250 IL = 1, LVNODES(K)
      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), 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