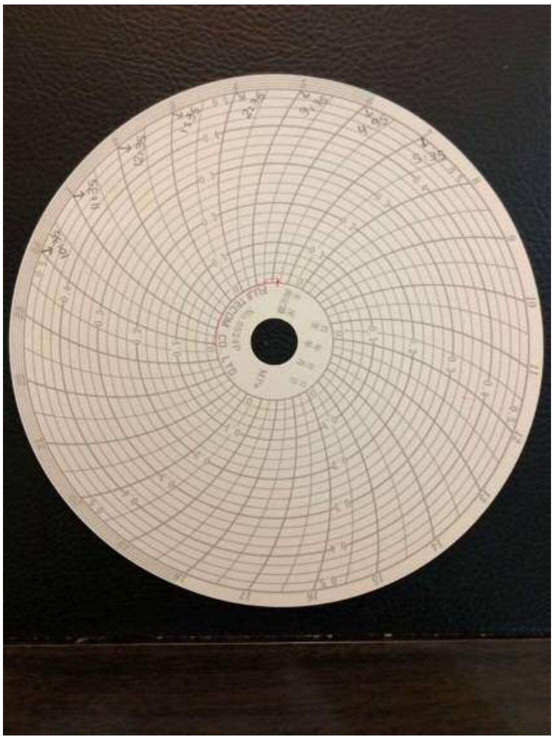
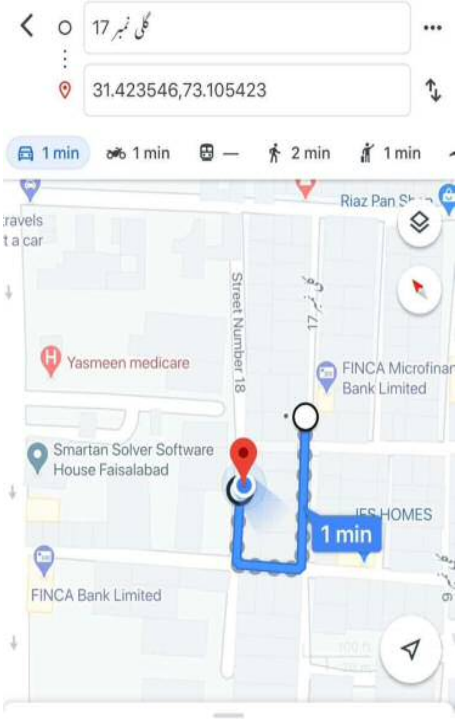
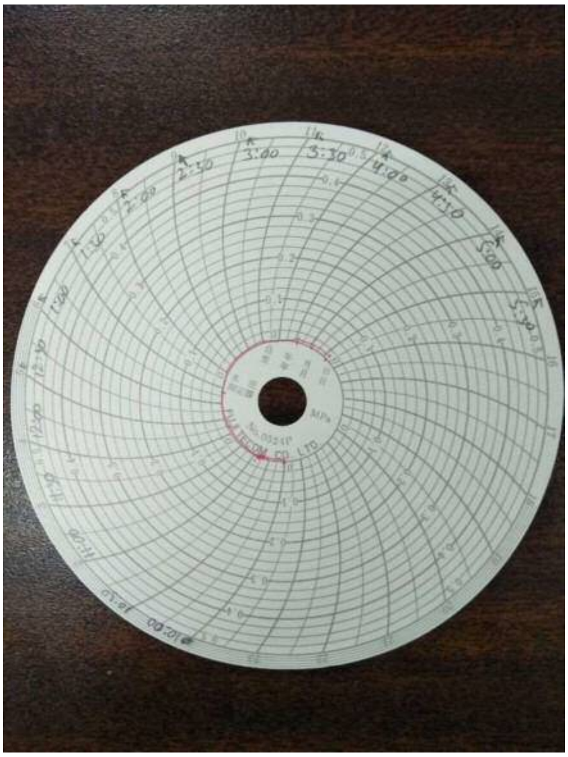
**29 26-2-2020 (Consumer Comments: low water pressure, use water by pumping)**

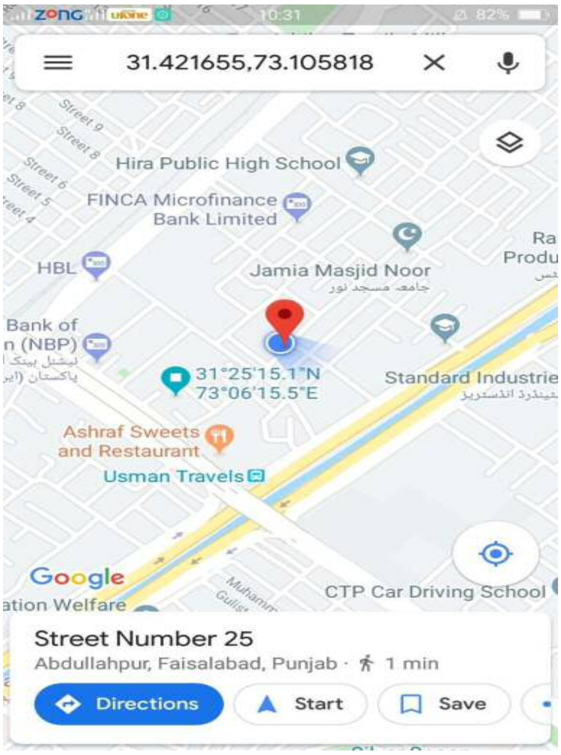



گلی نمبر 17

31.423546,73.105423

### 30 24-10-2019(Consumer Comments: Pressure is very low and water quality problem)




31.421655,73.105818

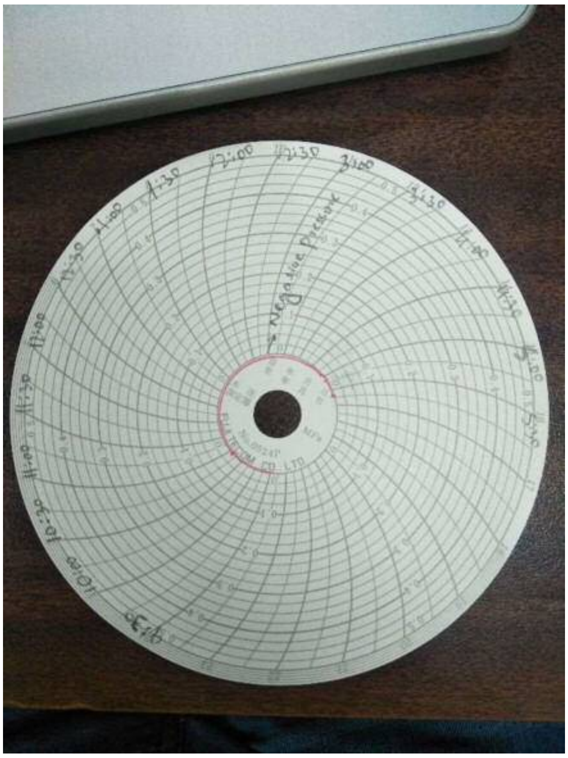
31°25'15.1"N
73°06'15.5"E

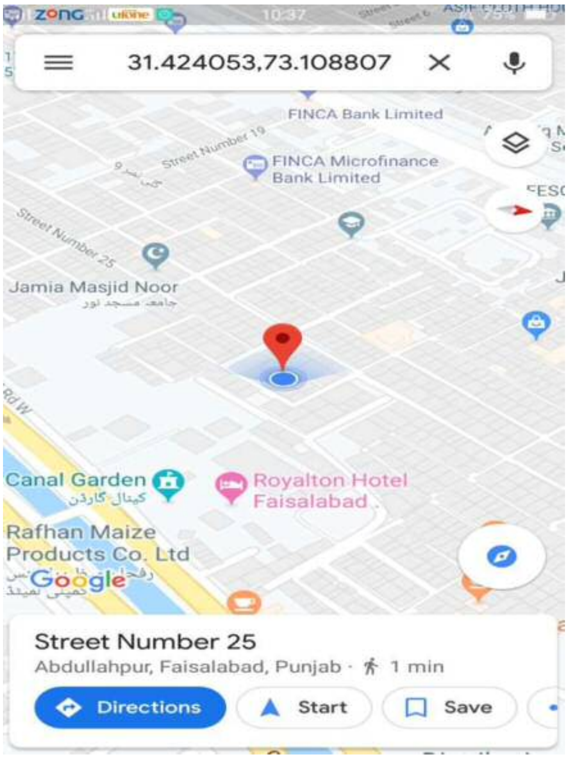
Street Number 25
Abdullahpur, Faisalabad, Punjab · 1 min





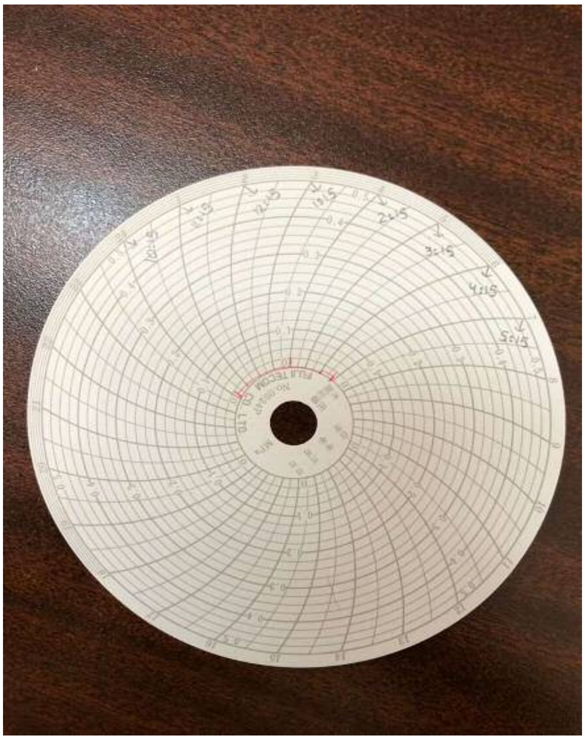
## 31 29-10-2019(Consumer Comments: water not come whole day)

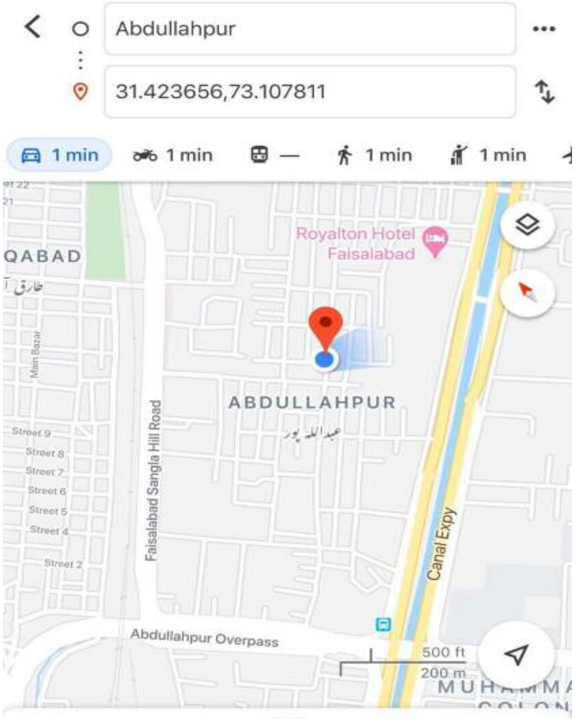



31.424053,73.108807

Street Number 25
Abdullahpur, Faisalabad, Punjab · 1 min

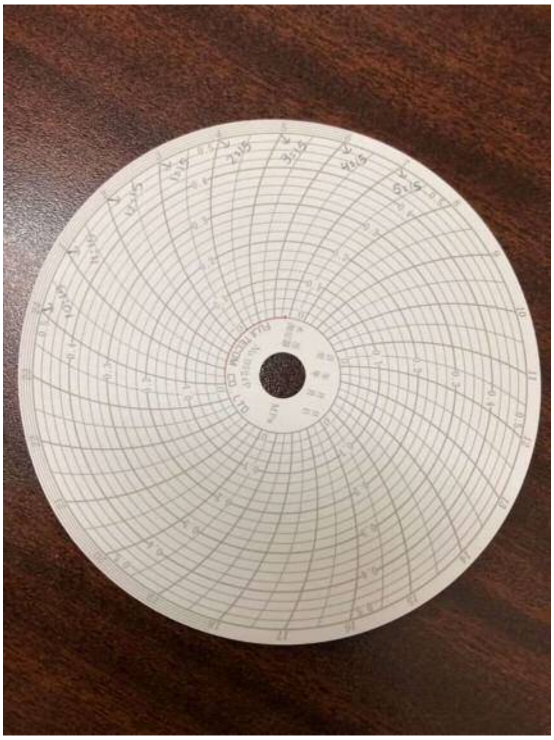
## 32 9-3-2020 (Consumer Comments: Low water pressure, not used daily due to low pressure)

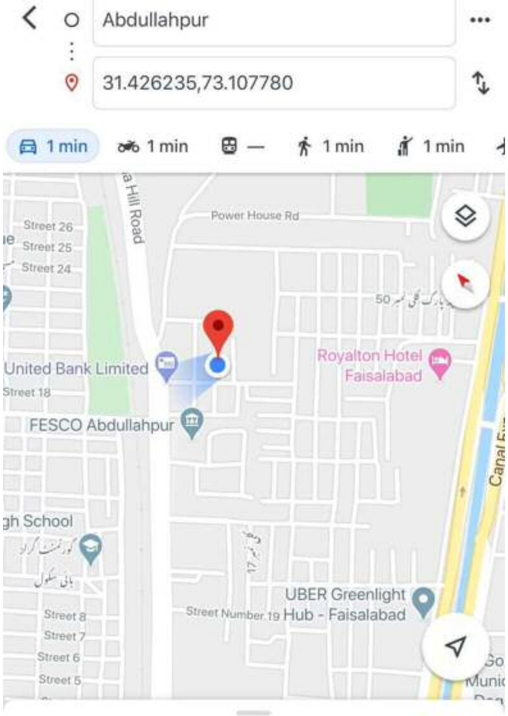



Abdullahpur

31.423656,73.107811

## 33 5-3-2020 (Consumer Comments: disconnect water connection due to low pressure)

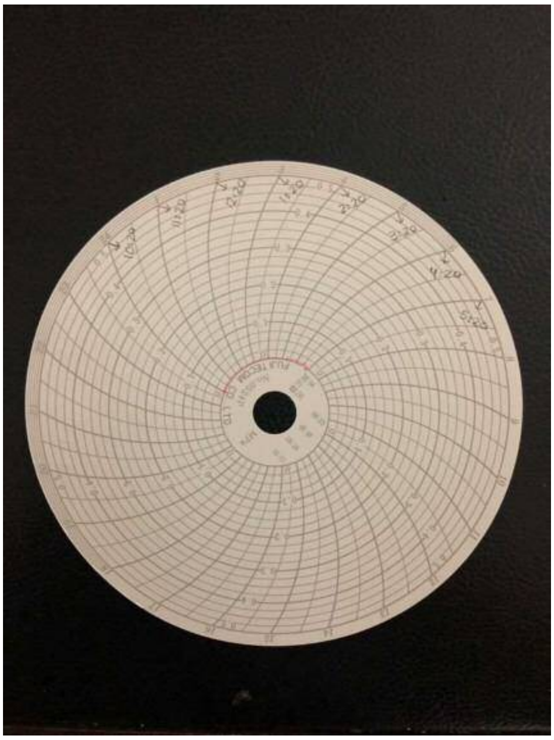


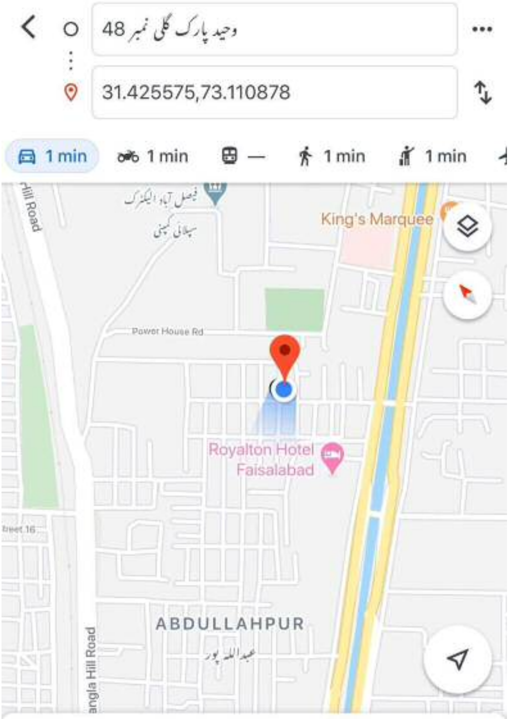


Abdullahpur

31.426235,73.107780

## 34 4-3-2020 (Consumer Comments: not using water due to low pressure and mixing with sewerage)

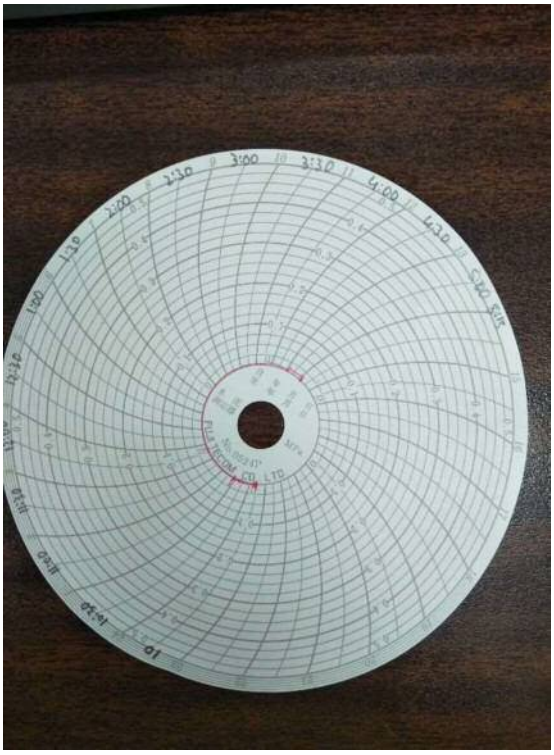


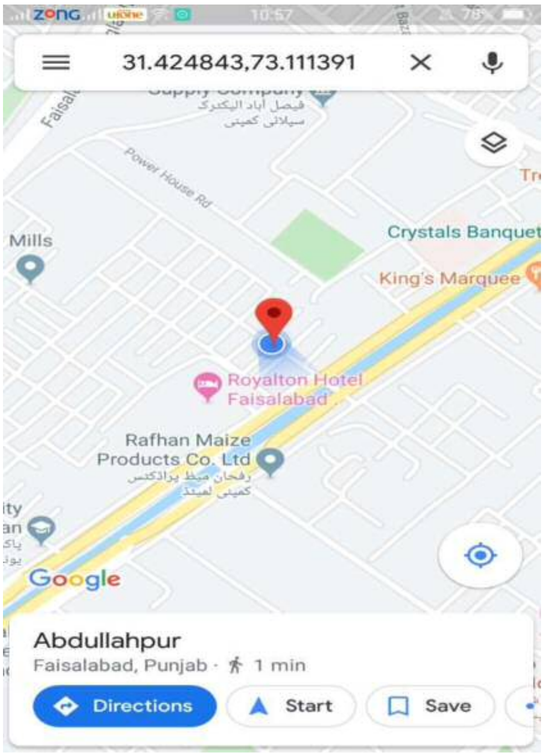


وحید پارک گلی نمبر 48

31.425575,73.110878

## 35 31-10-2019(Consumer Comments: Water pressure and water quality problem)

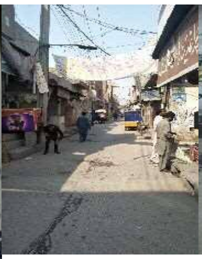
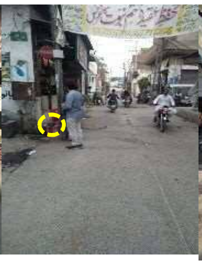



31.424843,73.111391

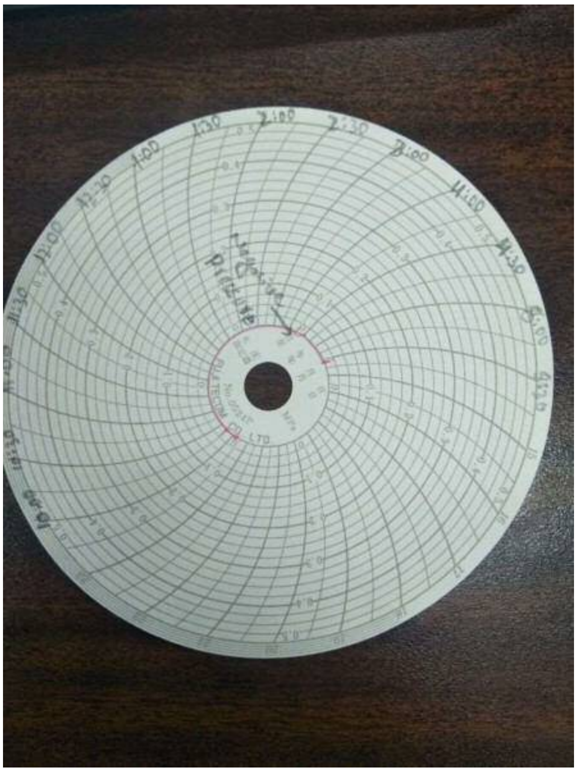
Abdullahpur

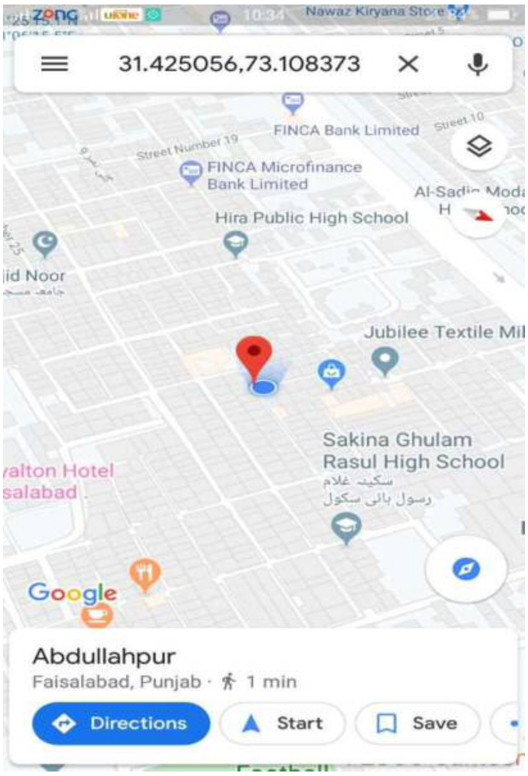
Faisalabad, Punjab · 1 min



## 36 5-11-2019(Consumer Comments: Water has zero pressure)





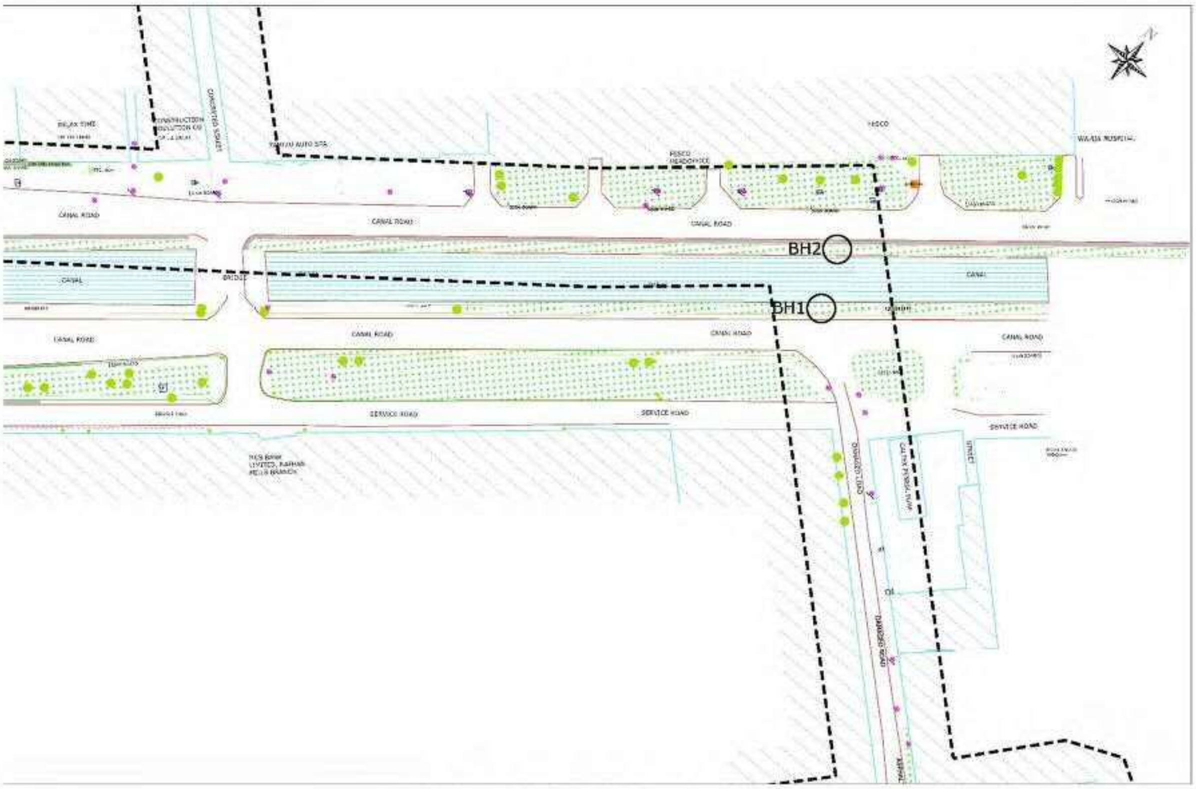
31.425056,73.108373

Abdullahpur

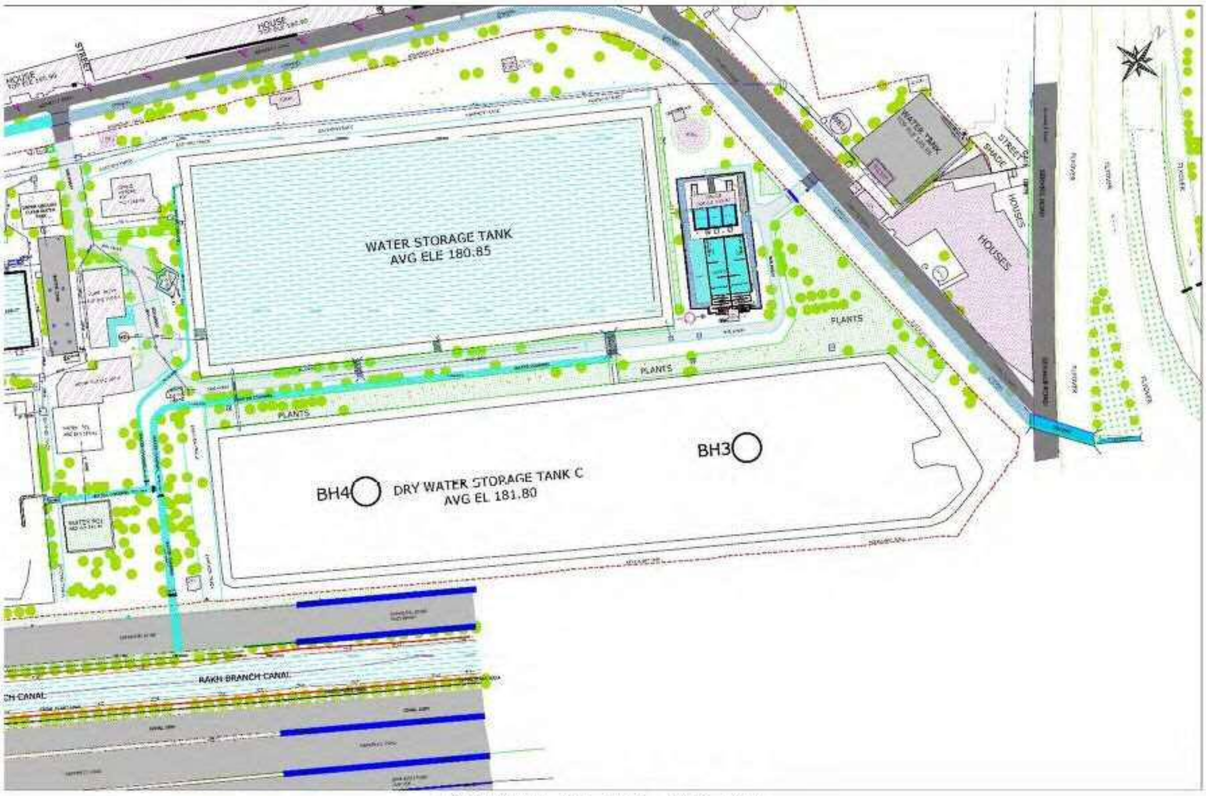
Faisalabad, Punjab · 1 min

# Appendix7 References

## (2) Results on Geotechnical Survey



LOCATION OF BH1 AND BH2

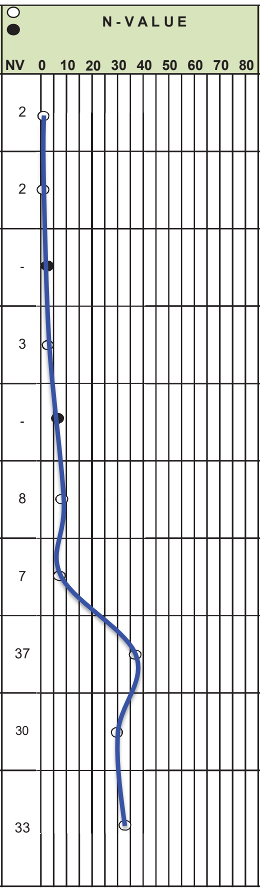


LOCATION OF BH3 AND BH4

| | | | | | |
|---|---|---|---|---|---|
| **FINITE ENGINEERING (PVT) LIMITED** | | | | **BOREHOLE NO.** | 1 |
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 1 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 0.00 to 10.00 m | **GROUND LEVEL** | 186.54 m |
| | | **START** | 15-May-19 | **WATER LEVEL** | 0.9 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 16-May-19 | | |
| | | **NORTHING** | 73° 6' 49.95'' | **EASTING** | 31° 25' 31.20'' |

## PRELIMINARY BORING LOG

| DEPTH (m) | TYPE OF SAMPLING | | Recovery Length( cm) | CR (%) | RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | SPT | ☒ | - | | | SOFT | 2 | Sample washed out<br>NB: (1)(1)(1) | | |
| 2.00 | SPT | ☒ | 55 | | | SOFT | 2 | (**CL- ML**) Brown to light Brown **SILTY CLAY**, soft, low Plasticity, moist<br>NB: (1)(1)(1) | ▦ | |
| 3.00 | UDS | ■ | - | - | - | - | - | - | | |
| 4.00 | SPT | ☒ | 34 | | | SOFT | 3 | **(CL- ML)** Brown to light Brown **SILTY CLAY**, soft, low Plasticity, moist<br>NB: (1)(1(2) | ▦ | |
| 5.00 | UDS | ■ | - | - | - | - | - | - | | |
| 6.00 | SPT | ☒ | 34 | | | FIRM | 8 | **(MC)** Brown to light Brown **CLAYEY SILT**, firm, low Plasticity, moist<br>NB: (2)(3)(5) | ▨ | |
| 7.00 | SPT | ☒ | 32 | | | LOOSE | 7 | (**SM**) Grey to light Grey, **SILTY SANDS**, medium to fine grained, loose, moist<br>NB: (04)(03)(04) | ▒ | |
| 8.00 | SPT | ☒ | 30 | | | DENSE | 37 | (**SW**) Grey to light Grey **Medium to Fine SANDS**, dense, moist<br>NB: (16)(17)(20) | ░ | |
| 9.00 | SPT | ☒ | 35 | | | MEDIUM DENSE | 30 | (**SW**) Grey to light Grey **Medium to Fine SANDS**, medium dense, moist<br>NB: (12)(15)(15) | ░ | |
| 10.00 | SPT | ☒ | 30 | | | DENSE | 33 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (12)(16)(17) | ░ | |



CONTINUE NEXT PAGE

Type of Sampling

☒ Standard Penetration Test (SPT)

■ UDS

- Sand ░
- Silty Sand ▒
- Clay ▥
- Silty Clay ▦
- Silt ▤
- Clayey Silty ▨

CONSISTENCY

| COHESIONLESS SOILS N-Value | COHESIONLESS SOILS Consistency | COHESIVE SOILS N-Value | COHESIVE SOILS Consistency |
|---|---|---|---|
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value
NMC = Natural Moisture Content
RQD = Rock Quality Designation
NB = Number of Blows
UDS = Undisturbed Sampling

SW = Sand
SM = Silty Sand
CL-ML = Silty Clay
ML = Silt
CL = Clay
MC = Clayey Silt

Prepared by:

Checked by:

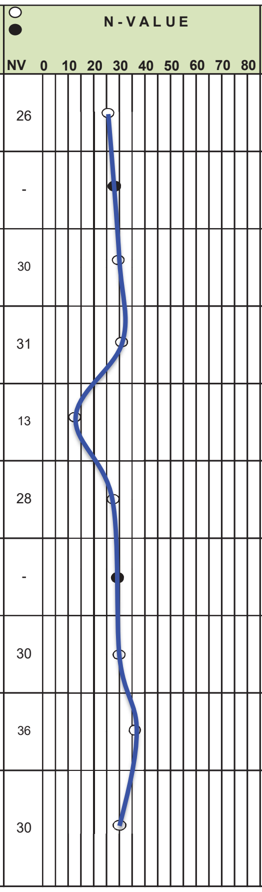
Certified by:

Date Issued:

Description of strata is according to ASTM Classification

| FINITE ENGINEERING (PVT) LIMITED | | | | BOREHOLE NO. | 1 |
|---|---|---|---|---|---|
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 2 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 10.00 to 20.00 m | **GROUND LEVEL** | 186.54 m |
| | | **START** | 15-May-19 | **WATER LEVEL** | 0.9 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 16-May-19 | | |
| | | **NORTHING** | 73° 6' 49.95'' | **EASTING** | 31° 25' 31.20'' |

**PRELIMINARY BORING LOG**



| DEPTH (m) | TYPE OF SAMPLING | Recovery Length (cm) | Recovery CR (%) | Recovery RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 11.00 | SPT | 29 | | | MEDIUM DENSE | 26 | **(SW)** Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist<br>NB: (11)(12)(14) | ░ | |
| 12.00 | UDS | - | - | - | - | - | - | | |
| 13.00 | SPT | 29 | | | MEDIUM DENSE | 30 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, medium dense, moist<br>NB: (09)(13)(17) | ░ | |
| 14.00 | SPT | 26 | | | DENSE | 31 | **(SW)** Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (10)(14)(17) | ░ | |
| 15.00 | SPT | 35 | | | MEDIUM DENSE | 13 | **(SM)** Grey to light Grey, **Fine grained, SILTY SANDS**, medium dense, moist<br>NB: (08)(06)(07) | ▨ | |
| 16.00 | SPT | 29 | | | MEDIUM DENSE | 28 | **(SW)** Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist<br>NB: (09)(13)(15) | ░ | |
| 17.00 | UDS | - | - | - | - | - | - | | |
| 18.00 | SPT | 31 | | | MEDIUM DENSE | 30 | **(SW)** Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist<br>NB: (12)(14)(16) | ░ | |
| 19.00 | SPT | 28 | | | DENSE | 36 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (14)(16)(18) | ░ | |
| 20.00 | SPT | 34 | | | MEDIUM DENSE | 30 | **(SW)** Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist<br>NB: (15)(16)(14) | ░ | |

C O N T I N U E  N E X T  P A G E

Type of Sampling

☒ Standard Penetration Test (SPT)

■ uds

- Sand ░
- Silty Sand ▨
- Clay ▥
- Silty Clay ▦
- Silt ☷
- Silty ▧

CONSISTENCY

| COHESIONLESS SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| N-Value | Consistency | N-Value | Consistency |
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value

NMC = Natural Moisture Content

RQD = Rock Quality Designation

NB = Number of Blows

UDS = Undisturbed Sampling

SW = Sand

SM = Silty Sand

CL-ML = Silty Clay

ML = Silt

CL = Clay

Prepared by:

Checked by:

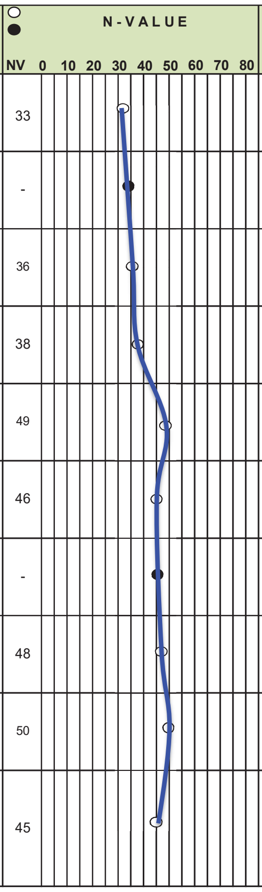
Certified by:

Date Issued:

Description of strata is according to ASTM Classification

| **FINITE ENGINEERING (PVT) LIMITED** | | | | **BOREHOLE NO.** | 1 |
|---|---|---|---|---|---|
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 3 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 20.00 to 30.00 m | **GROUND LEVEL** | 186.54 m |
| | | **START** | 17-May-19 | **WATER LEVEL** | 0.9 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 18-May-19 | | |
| | | **NORTHING** | 73° 6' 49.95'' | **EASTING** | 31° 25' 31.20'' |

**PRELIMINARY BORING LOG**



| DEPTH (m) | TYPE OF SAMPLING | Recovery | | | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | | Length (cm) | CR (%) | RQD (%) | | | | | |
| 21.00 | SPT | 29 | | | DENSE | 33 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (14)(16)(17) | ░ | |
| 22.00 | UDS | - | - | - | - | - | - | | |
| 23.00 | SPT | 31 | | | DENSE | 36 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (17)(17)(19) | ░ | |
| 24.00 | SPT | 42 | | | DENSE | 38 | **(SW),** Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist, **(CL)** Brown to light Brown **CLAY** of few centimeter<br>NB: (20)(21)(17) | ░<br>▥ | |
| 25.00 | SPT | 39 | | | DENSE | 49 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (23)(24)(25) | ░ | |
| 26.00 | SPT | 31 | | | DENSE | 46 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (22)(22)(24) | ░ | |
| 27.00 | UDS | - | - | - | - | - | - | | |
| 28.00 | SPT | 28 | | | VERY DENSE | 48 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, very dense, moist<br>NB: (21)(23)(25) | ░ | |
| 29.00 | SPT | 24 | | | VERY DENSE | 50 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, very dense, moist<br>NB: (23)(24)(26) | ░ | |
| 30.00 | SPT | 26 | | | VERY DENSE | 45 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, very dense, moist<br>NB: (23)(24)(21) | ░ | |

CONTINUE NEXT PAGE

Type of Sampling

⊠ Standard Penetration Test (SPT)

■ UDS

- Sand ░
- Silty Sand ▤
- Clay ▥
- Silty Clay ▦
- Silt ☷
- Silty ▨

CONSISTENCY

| COHESIONLESS SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| N-Value | Consistency | N-Value | Consistency |
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value
NMC = Natural Moisture Content
RQD = Rock Quality Designation
NB = Number of Blows
UDS = Undisturbed Sampling

SW = Sand
SM = Silty Sand
CL-ML = Silty Clay
ML = Silt
CL = Clay

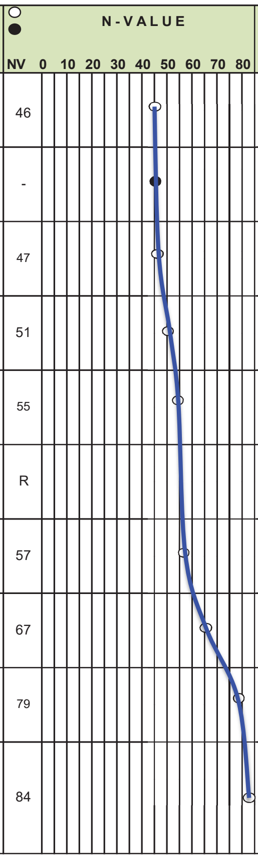
Prepared by:
Checked by:
Certified by:
Date Issued:

Description of strata is according to ASTM Classification

| | | | | | |
|---|---|---|---|---|---|
| **FINITE ENGINEERING (PVT) LIMITED** | | | | **BOREHOLE NO.** | **1** |
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 4 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 30.00 to 40.00 m | **GROUND LEVEL** | 186.54 m |
| | | **START** | 17-May-19 | **WATER LEVEL** | 0.9 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 18-May-19 | | |
| | | **NORTHING** | 73° 6’ 49.95’’ | **EASTING** | 31° 25’ 31.20’’ |

## PRELIMINARY BORING LOG

| DEPTH (m) | TYPE OF SAMPLING | Recovery Length (cm) | Recovery CR (%) | Recovery RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 31.00 | SPT | 35 | | | DENSE | 46 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (21)(23)(23) | ░ | |
| 32.00 | UDS | - | - | - | - | - | - | | |
| 33.00 | SPT | 27 | | | DENSE | 47 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (04)(22)(25) | ░ | |
| 34.00 | SPT | 26 | | | VERY DENSE | 51 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (22)(25)(26) | ░ | |
| 35.00 | SPT | 25 | | | VERY DENSE | 55 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (23)(27)(28) | ░ | |
| 36.00 | SPT | 40 | | | VERY DENSE | R | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (35) (R) | ░ | |
| 37.00 | SPT | 29 | | | VERY DENSE | 57 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (12)(29)(28) | ░ | |
| 38.00 | SPT | 31 | | | VERY DENSE | 67 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (30)(31)(36) | ░ | |
| 39.00 | SPT | 28 | | | VERY DENSE | 79 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (35)(38)(41) | ░ | |
| 40.00 | SPT | 26 | | | VERY DENSE | 84 | **(SW)** Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (35)(41)(43) | ░ | |



CONTINUE NEXT PAGE

Type of Sampling

Standard Penetration Test (SPT)

UDS

- Sand ░
- Silty Sand ▨
- Clay ▥
- Silty Clay ▦
- Silt ▤
- Silty ▨

CONSISTENCY

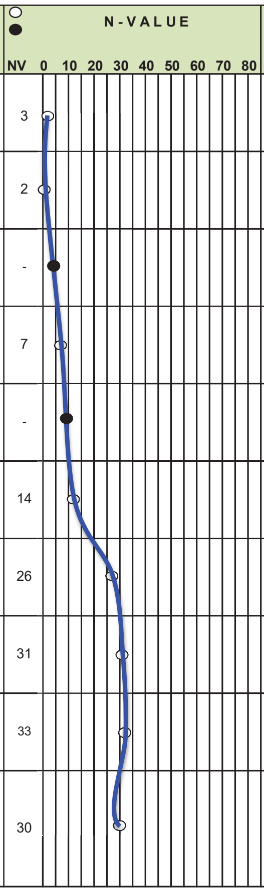
| COHESIONLESS SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| N-Value | Consistency | N-Value | Consistency |
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

| | | | | |
|---|---|---|---|---|
| NV | = N - Value | SW | = Sand | Prepared by: |
| NMC | = Natural Moisture Content | SM | = Silty Sand | Checked by: |
| RQD | = Rock Quality Designation | CL-ML | = Silty Clay | |
| NB | = Number of Blows | ML | = Silt | Certified by: |
| UDS | = Undisturbed Sampling | CL | = Clay | Date Issued: |

Description of strata is according to ASTM Classification

| FINITE ENGINEERING (PVT) LIMITED | | | | BOREHOLE NO. | 2 |
|---|---|---|---|---|---|
| PROJECT | Improvement of Water Treatment Plant and Water Distribution System, Faisalabad | | | | |
| | | TOTAL DEPTH | 40 m | SHEET | 1 of 4 |
| LOCATION | Rakh Branch Canal, Abdullah Pur,Faisalabad | LOGGED | 0.00 to 10.00 m | GROUND LEVEL | |
| | | START | 17-May-19 | WATER LEVEL | 7 m |
| TYPE OF BORING | Rotary | FINISH | 18-May-19 | | |
| | | NORTHING | 73° 6' 48.96'' | EASTING | 31° 25' 31.35'' |

## PRELIMINARY BORING LOG



| DEPTH (m) | TYPE OF SAMPLING | Recovery Length(cm) | Recovery CR (%) | Recovery RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 1.00 | SPT | 16 | | | SOFT | 3 | (**CL**) Brown to light Brown **CLAY**, soft, lowly Plastic, moist<br>NB: (1)(1)(2) | | |
| 2.00 | SPT | 20 | | | SOFT | 2 | (**CL**) Brown to light Brown **CLAY**, soft, lowly Plastic, moist<br>NB: (1)(1)(1) | | |
| 3.00 | UDS | - | - | - | - | - | - | | |
| 4.00 | SPT | 30 | | | FIRM | 7 | (**CL-ML**) Brown to light Brown **Silty CLAY**, firm, lowly Plastic, moist<br>NB: (3)(3(4) | | |
| 5.00 | UDS | - | - | - | - | - | - | | |
| 6.00 | SPT | 27 | | | STIFF | 14 | (**CL-ML**) Grey to light Grey **Silty CLAY**, stiff, lowly Plastic, moist<br>NB: (5)(7)(7) | | |
| 7.00 | SPT | 32 | | | MEDIUM DENSE | 26 | (**SM**) Grey to light Grey, **Silty SANDS**, medium dense, moist<br>NB: (06)(11)(15) | | |
| 8.00 | SPT | 36 | | | DENSE | 31 | (**SW**) Grey to light Grey **Medium to Fine SANDS**, dense, moist<br>NB: (12)(14)(17) | | |
| 9.00 | SPT | 32 | | | DENSE | 33 | (**SW**) Grey to light Grey **Fine SANDS**,dense, moist<br>NB: (12)(16)(17) | | |
| 10.00 | SPT | 25 | | | MEDIUM DENSE | 30 | (**SW**) Grey to light Grey **Fine SANDS**, dense, moist<br>NB: (11)(15)(15) | | |

CONTINUE NEXT PAGE

Type of Sampling

Standard Penetration Test (SPT)

UDS

- Sand
- Silty Sand
- Clay
- Silty Clay
- Silt
- Silty

CONSISTENCY

| COHESIONLESS SOILS N-Value | COHESIONLESS SOILS Consistency | COHESIVE SOILS N-Value | COHESIVE SOILS Consistency |
|---|---|---|---|
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value
NMC = Natural Moisture Content
RQD = Rock Quality Designation
NB = Number of Blows
UDS = Undisturbed Sampling

SW = Sand
SM = Silty Sand
CL-ML = Silty Clay
ML = Silt
CL = Clay

Description of strata is according to ASTM Classification

Prepared by:

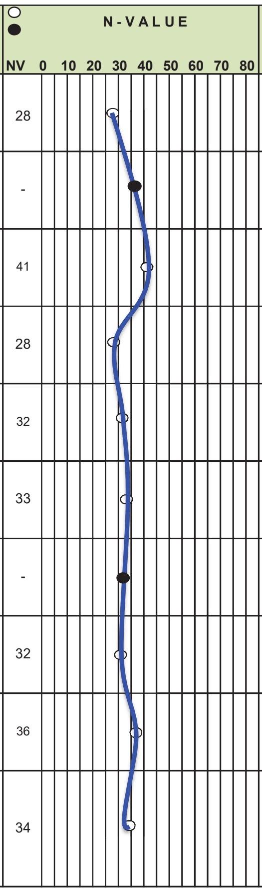
Checked by:

Certified by:

Date Issued:

| **FINITE ENGINEERING (PVT) LIMITED** | | | | **BOREHOLE NO.** | **2** |
|---|---|---|---|---|---|
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 2 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 10.00 to 20.00 m | **GROUND LEVEL** | |
| | | **START** | 17-May-19 | **WATER LEVEL** | 7 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 18-May-19 | | |
| | | **NORTHING** | 73° 6' 48.96'' | **EASTING** | 31° 25' 31.35'' |

## PRELIMINARY BORING LOG



| DEPTH (m) | TYPE OF SAMPLING | Recovery Length (cm) | Recovery CR (%) | Recovery RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 11.00 | SPT ☒ | 29 | | | MEDIUM DENSE | 28 | (**SW**) Grey to light Grey , **Fine SANDS**, medium dense, moist<br>NB: (11)(13)(15) | ░ | |
| 12.00 | UDS ■ | - | - | - | - | - | - | | |
| 13.00 | SPT ☒ | 26 | | | DENSE | 41 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (04)(19)(22) | ░ | |
| 14.00 | SPT ☒ | 30 | | | MEDIUM DENSE | 28 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist<br>NB: (11)(13)(15) | ░ | |
| 15.00 | SPT ☒ | 29 | | | DENSE | 32 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (13)(15)(17) | ░ | |
| 16.00 | SPT ☒ | 27 | | | DENSE | 33 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (15)(10)(17) | ░ | |
| 17.00 | UDS ■ | - | - | - | - | - | - | | |
| 18.00 | SPT ☒ | 32 | | | DENSE | 32 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (13)(15)(17) | ░ | |
| 19.00 | SPT ☒ | 28 | | | DENSE | 36 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (14)(17)(19) | ░ | |
| 20.00 | SPT ☒ | 32 | | | MEDIUM DENSE | 34 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (10)(18)(16) | ░ | |

C O N T I N U E N E X T P A G E

| Type of Sampling | | | |
|---|---|---|---|
| ☒ | Standard Penetration Test (SPT) | - Sand | ░ |
| ■ | uds | - Silty Sand | ▤ |
| | | - Clay | ▥ |
| | | - Silty Clay | ▦ |
| | | - Silt | ▭ |
| | | - Silty | ▨ |

CONSISTENCY

| COHESIONLESS SOILS N-Value | COHESIONLESS SOILS Consistency | COHESIVE SOILS N-Value | COHESIVE SOILS Consistency |
|---|---|---|---|
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value
SW = Sand
NMC = Natural Moisture Content
SM = Silty Sand
RQD = Rock Quality Designation
CL-ML = Silty Clay
NB = Number of Blows
ML = Silt
UDS = Undisturbed Sampling
CL = Clay

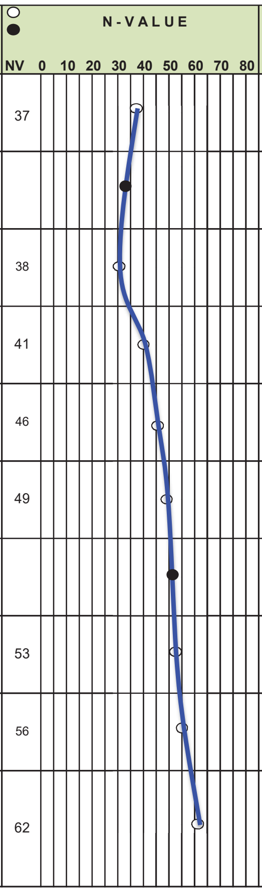
Prepared by:
Checked by:
Certified by:
Date Issued:

Description of strata is according to ASTM Classification

| **FINITE ENGINEERING (PVT) LIMITED** | | | | **BOREHOLE NO.** | 2 |
|---|---|---|---|---|---|
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 3 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 20.00 to 30.00 m | **GROUND LEVEL** | |
| | | **START** | 17-May-19 | **WATER LEVEL** | 7 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 18-May-19 | | |
| | | **NORTHING** | 73° 6' 48.96'' | **EASTING** | 31° 25' 31.35'' |

## PRELIMINARY BORING LOG

| DEPTH (m) | TYPE OF SAMPLING | Recovery Length (cm) | Recovery CR (%) | Recovery RQD (%) | Consistency | ○ ● N - VALUE<br>NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 21.00 | SPT | 26 | | | DENSE | 37 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (15)(18)(19) | ░ | |
| 22.00 | UDS | | | | | | | | |
| 23.00 | SPT | 31 | | | DENSE | 38 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, dense, moist<br>NB: (16)(18)(20) | ░ | |
| 24.00 | SPT | 29 | | | DENSE | 41 | **(SW),** Grey to light Grey, **Medium to Fine SANDS**, medium dense, moist, **(CL)** Brown to light Brown **CLAY** of few centimeter<br>NB: (18)(19)(22) | ░<br>▥ | |
| 25.00 | SPT | 35 | | | DENSE | 46 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (20)(22)(24) | ░ | |
| 26.00 | SPT | 31 | | | DENSE | 49 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, dense, moist<br>NB: (22)(23)(26) | ░ | |
| 27.00 | UDS | | | | | | | | |
| 28.00 | SPT | 26 | | | VERY DENSE | 53 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, very dense, moist<br>NB: (24)(26)(27) | ░ | |
| 29.00 | SPT | 33 | | | VERY DENSE | 56 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, very dense, moist<br>NB: (25)(27)(29) | ░ | |
| 30.00 | SPT | 27 | | | VERY DENSE | 62 | (**SW**) Grey to light Grey, **Medium to Fine SANDS**, very dense, moist<br>NB: (27)(30)(32) | ░ | |



C O N T I N U E   N E X T   P A G E

| Type of Sampling | |
|---|---|
| ☒ Standard Penetration Test (SPT) | - Sand ░ |
| ■ UDS | - Silty Sand |
| | - Clay ▥ |
| | - Silty Clay |
| | - Silt |
| | - Silty |

CONSISTENCY

| COHESIONLESS SOILS N-Value | COHESIONLESS SOILS Consistency | COHESIVE SOILS N-Value | COHESIVE SOILS Consistency |
|---|---|---|---|
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value  SW = Sand

NMC = Natural Moisture Content  SM = Silty Sand

RQD = Rock Quality Designation  CL-ML = Silty Clay

NB = Number of Blows  ML = Silt

UDS = Undisturbed Sampling  CL = Clay

Description of strata is according to ASTM Classification

Prepared by:

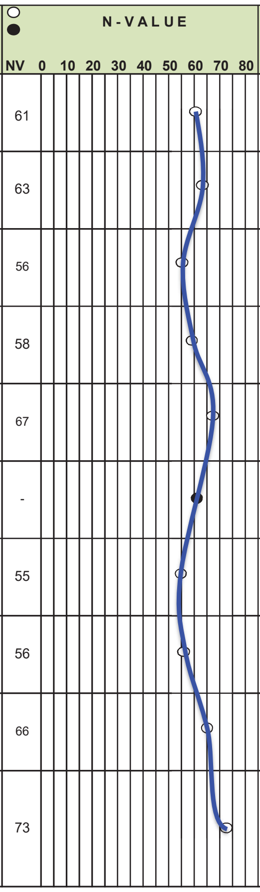
Checked by:

Certified by:

Date Issued:

| FINITE ENGINEERING (PVT) LIMITED | | | | BOREHOLE NO. | 2 |
|---|---|---|---|---|---|
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 40 m | **SHEET** | 4 of 4 |
| **LOCATION** | Rakh Branch Canal, Abdullah Pur,Faisalabad | **LOGGED** | 30.00 to 40.00 m | **GROUND LEVEL** | |
| | | **START** | 17-May-19 | **WATER LEVEL** | 7 m |
| **TYPE OF BORING** | Rotary | **FINISH** | 18-May-19 | | |
| | | **NORTHING** | 73° 6' 48.96'' | **EASTING** | 31° 25' 31.35'' |

## PRELIMINARY BORING LOG



| DEPTH (m) | TYPE OF SAMPLING | Recovery Length (cm) | CR (%) | RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 31.00 | SPT | 29 | | | VERY DENSE | 61 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (26)(29)(32) | ░ | |
| 32.00 | SPT | 32 | | | | 63 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (26)(30)(33) | ░ | |
| 33.00 | SPT | 29 | | | VERY DENSE | 56 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (20)(27)(29) | ░ | |
| 34.00 | SPT | 29 | | | VERY DENSE | 58 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (22)(27)(31) | ░ | |
| 35.00 | SPT | 26 | | | VERY DENSE | 67 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (29)(32)(35) | ░ | |
| 36.00 | UDS | - | - | - | - | - | - | | |
| 37.00 | SPT | 29 | | | | 55 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (25)(26)(29) | ░ | |
| 38.00 | SPT | 26 | | | VERY DENSE | 56 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (16)(27)(29) | ░ | |
| 39.00 | SPT | 31 | | | VERY DENSE | 66 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (8)(32)(34) | ░ | |
| 40.00 | SPT | 27 | | | VERY DENSE | 73 | (**SW**) Grey to light Grey , **Medium to Fine SANDS**, very dense, moist<br>NB: (29)(35)(38) | ░ | |

CONTINUE NEXT PAGE

Type of Sampling

| | |
|---|---|
| ☒ | Standard Penetration Test (SPT) |
| ■ | UDS |

| | |
|---|---|
| - Sand | ░ |
| - Silty Sand | ▨ |
| - Clay | ▥ |
| - Silty Clay | ▦ |
| - Silt | ▤ |
| - Silty | ▧ |

CONSISTENCY

| COHESIONLESS SOILS | | COHESIVE SOILS | |
|---|---|---|---|
| N-Value | Consistency | N-Value | Consistency |
| 0 - 4 | Very Loose | 0 - 2 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | Stiff |
| > 50 | Very Dense | 15 - 30 | Very Stiff |
| | | > 30 | Hard |

NV = N - Value
NMC = Natural Moisture Content
RQD = Rock Quality Designation
NB = Number of Blows
UDS = Undisturbed Sampling

SW = Sand
SM = Silty Sand
CL-ML = Silty Clay
ML = Silt
CL = Clay

Prepared by:
Checked by:
Certified by:
Date Issued:

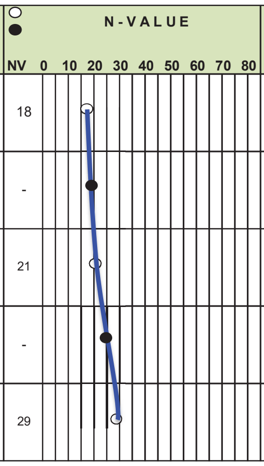
Description of strata is according to ASTM Classification

## FINITE ENGINEERING (PVT) LIMITED

| | | | | | |
|---|---|---|---|---|---|
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | **BOREHOLE NO.** | 3 |
| | | **TOTAL DEPTH** | 5 m | **SHEET** | 1 of 1 |
| **LOCATION** | Old Jhal Khanuana Water Treatment Plant | **LOGGED** | 0.00 to 5.00 m | **GROUND LEVEL** | 181.25 m |
| | | **START** | 19-May-19 | **WATER LEVEL** | - |
| **TYPE OF BORING** | Rotary | **FINISH** | 19-May-19 | | |
| | | **NORTHING** | 73° 5' 32.87'' | **EASTING** | 31° 24' 36.78'' |

### PRELIMINARY BORING LOG

| DEPTH (m) | TYPE OF SAMPLING | | Recovery Length(cm) | CR (%) | RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | SPT | ☒ | 28 | | | MEDIUM DENSE | 18 | (**SM**) Grey to light Grey, **Fine to very Fine grained, SILTY SANDS**, medium dense<br>NB: (05)(08)(10) | ▨ | |
| 2.00 | SPT | ■ | - | - | - | - | - | | | |
| 3.00 | UDS | ☒ | 30 | | | MEDIUM DENSE | 21 | (**SM**) Grey to light Grey, **Fine to very Fine grained, SILTY SANDS**, medium dense<br>NB: (08)(09)(12) | ▨ | |
| 4.00 | SPT | ■ | - | - | - | - | - | | | |
| 5.00 | UDS | ☒ | 26 | | | MEDIUM DENSE | 29 | (**SW**) Grey to light Grey, **Fine to very Fine grained, SANDS**, medium dense<br>NB: (09)(14)(15) | ░ | |



Type of Sampling

| | | | |
|---|---|---|---|
| ☒ | Standard Penetration Test (SPT) | - Sand | ░ |
| ■ | UDS | - Silty Sand | ▨ |
| | | - Clay | ▥ |
| | | - Silty Clay | ▥ |
| | | - Silt | ▤ |
| | | - Clayey Silty | ▨ |

CONSISTENCY

COHESIONLESS SOILS

| N-Value | Consistency |
|---|---|
| 0 - 4 | Very Loose |
| 4 - 10 | Loose |
| 10 - 30 | Medium Dense |
| 30 - 50 | Dense |
| > 50 | Very Dense |

COHESIVE SOILS

| N-Value | Consistency |
|---|---|
| 0 - 2 | Very Soft |
| 2 - 4 | Soft |
| 4 - 8 | Medium Stiff |
| 8 - 15 | Stiff |
| 15 - 30 | Very Stiff |
| > 30 | Hard |

NV = N - Value
NMC = Natural Moisture Content
RQD = Rock Quality Designation
NB = Number of Blows
UDS = Undisturbed Sampling

SW = Sand
SM = Silty Sand
CL-ML = Silty Clay
ML = Silt
CL = Clay
MC = Clayey Silt

Prepared by:
Checked by:
Certified by:
Date Issued:

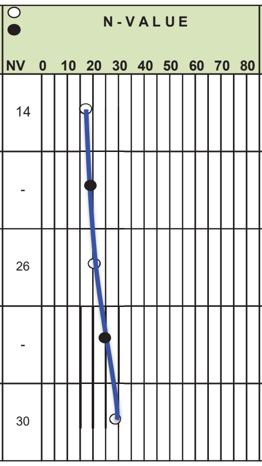
Description of strata is according to ASTM Classification

## FINITE ENGINEERING (PVT) LIMITED

| | | | | | |
|---|---|---|---|---|---|
| **BOREHOLE NO.** | 4 | | | | |
| **PROJECT** | **Improvement of Water Treatment Plant and Water Distribution System, Faisalabad** | | | | |
| | | **TOTAL DEPTH** | 5 m | **SHEET** | 1 of 1 |
| **LOCATION** | Old Jhal Khanuana Water Treatment Plant | **LOGGED** | 0.00 to 5.00 m | **GROUND LEVEL** | 180.95 m |
| | | **START** | 19-May-19 | **WATER LEVEL** | - |
| **TYPE OF BORING** | Rotary | **FINISH** | 19-May-19 | | |
| | | **NORTHING** | 73° 5' 29.46'' | **EASTING** | 31° 24' 34.78'' |

### PRELIMINARY BORING LOG

| DEPTH (m) | TYPE OF SAMPLING | Recovery Length (cm) | Recovery CR (%) | Recovery RQD (%) | Consistency | NV | DESCRIPTION | SOIL SYMBOL | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 1.00 | SPT ☒🟦 | 27 | | | MEDIUM DENSE | 14 | (**SM**) Grey to light Grey, **Fine to very Fine grained, SILTY SANDS**, medium dense<br>NB: (04)(07)(07) | ▨ | |
| 2.00 | SPT ⬛ | - | - | - | - | - | | | |
| 3.00 | UDS ☒🟦 | 28 | | | MEDIUM DENSE | 26 | (**SM**) Grey to light Grey, **Fine to very Fine grained, SILTY SANDS**, medium dense<br>NB: (08)(12)(14) | ▨ | |
| 4.00 | UDS ⬛ | - | - | - | - | - | | | |
| 5.00 | SPT ☒🟦 | 35 | | | MEDIUM DENSE | 30 | (**SW**) Grey to light Grey, **Fine to very Fine grained, SANDS**, medium dense<br>NB: (10)(14)(16) | ░ | |



Type of Sampling

| | |
|---|---|
| ☒🟦 | Standard Penetration Test (SPT) |
| ⬛ | UDS |

- Sand ░
- Silty Sand ▨
- Clay ▥
- Silty Clay ▥
- Silt ▤
- Clayey Silty ▨

CONSISTENCY

COHESIONLESS SOILS

| N-Value | Consistency |
|---|---|
| 0 - 4 | Very Loose |
| 4 - 10 | Loose |
| 10 - 30 | Medium Dense |
| 30 - 50 | Dense |
| > 50 | Very Dense |

COHESIVE SOILS

| N-Value | Consistency |
|---|---|
| 0 - 2 | Very Soft |
| 2 - 4 | Soft |
| 4 - 8 | Medium Stiff |
| 8 - 15 | Stiff |
| 15 - 30 | Very Stiff |
| > 30 | Hard |

NV = N - Value

NMC = Natural Moisture Content

RQD = Rock Quality Designation

NB = Number of Blows

UDS = Undisturbed Sampling

SW = Sand

SM = Silty Sand

CL-ML = Silty Clay

ML = Silt

CL = Clay

MC = Clayey Silt

Prepared by:

Checked by:

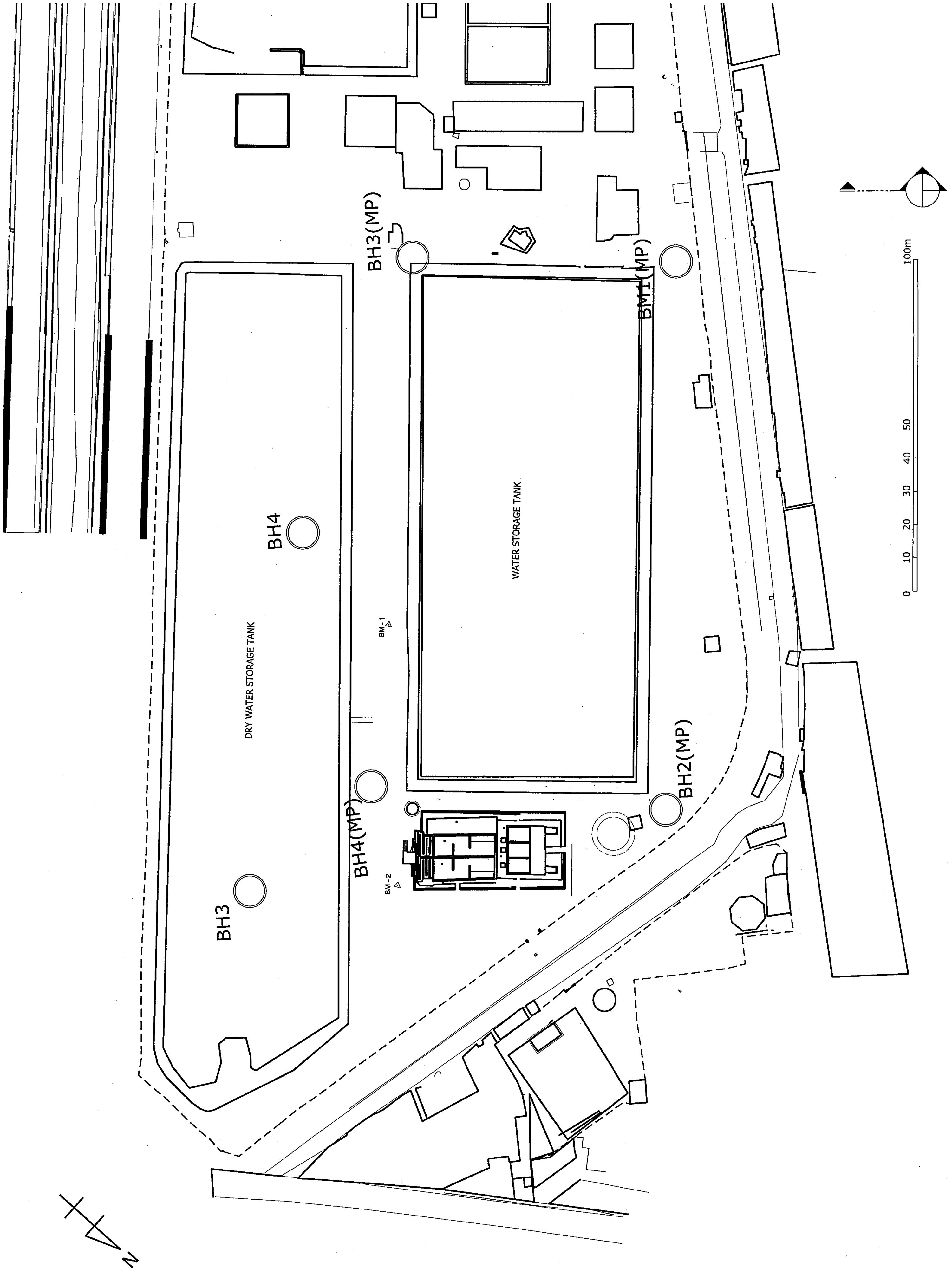
Certified by:

Date Issued:

Description of strata is according to ASTM Classification

***Table 6:** Summary of Laboratory Results*

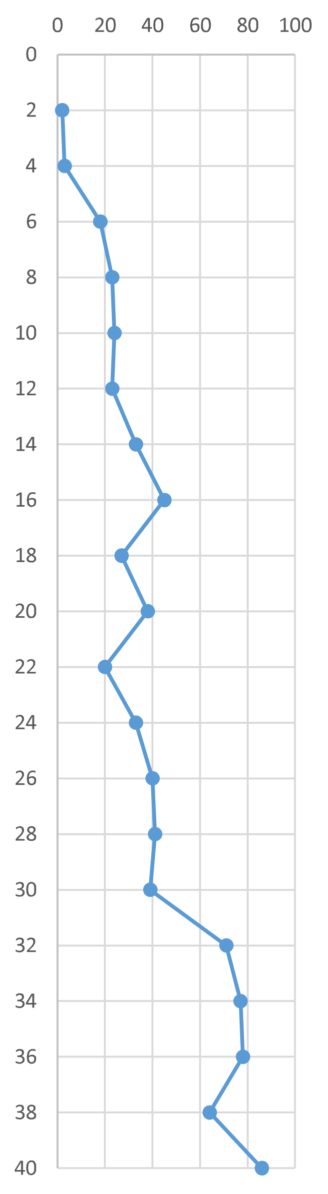
| BH No. | Depth (m) | Sample | NMC (%) | Specific $G_s$ | Bulk (kN/m³) | Particle Size Distribution | | | Particle Size Distribution | | | Direct Share Test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Gravel (%) | Sand (%) | Silt & Clay (%) | L.L (%) | P.L (%) | P.I | Cohesion (kPa) | Angle of internal Friction |
| BH-1 | 1 | 1 (DS) | 19.3 | 2.68 | - | 0 | 11 | 89 | - | - | - | - | - |
| | 3 | 29 (UDS) | 27.3 | 2.67 | 19.3 | 0 | 9 | 91 | 29 | 20 | 9 | - | - |
| | 5 | 30 (UDS) | 22 | 2.68 | 20 | 0 | 10 | 90 | 27 | 20 | 7 | - | - |
| | 10 | 2 (DS) | 14 | 2.65 | - | 0 | 96 | 4 | - | - | - | - | - |
| | 12 | 15 (UDS) | - | - | 17.3 | - | - | - | - | - | - | 1.4 | 29 |
| | 17 | 16 (UDS) | - | - | 17.9 | - | - | - | - | - | - | 0.8 | 30 |
| | 20 | 3 (DS) | 10.6 | 2.66 | - | 0 | 97 | 3 | - | - | - | - | - |
| | 22 | 17 (UDS) | - | - | 16.7 | - | - | - | - | - | - | 1 | 31 |
| | 27 | 18 (UDS) | - | - | 18.1 | - | - | - | - | - | - | 0.9 | 32 |
| | 32 | 19 (UDS) | - | - | 17.2 | - | - | - | - | - | - | 1.1 | 32 |
| | 40 | 4 (DS) | 28.3 | 2.67 | - | 0 | 97 | 3 | - | - | - | - | - |
| BH-2 | 1 | 5 (DS) | 17.3 | 2.68 | - | 26 | 23 | 51 | - | - | - | - | - |
| | 3 | 31 (UDS) | 17 | 2.67 | 18.4 | 0 | 12 | 88 | 25 | 20 | 5 | - | - |
| | 5 | 32 (UDS) | 14.1 | 2.69 | 19.6 | 12 | 7 | 81 | 28 | 20 | 8 | - | - |
| | 10 | 6 (DS) | 13.6 | 2.67 | - | 0 | 96 | 4 | - | - | - | - | - |
| | 12 | 20 (UDS) | - | - | 17.3 | - | - | - | - | - | - | 0.4 | 29 |
| | 17 | 21 (UDS) | - | - | 16.2 | - | - | - | - | - | - | 0.8 | 30 |
| | 20 | 7 (DS) | 22.7 | 2.65 | - | 0 | 97 | 3 | - | - | - | - | - |
| | 22 | 22 (UDS) | - | - | 17.6 | - | - | - | - | - | - | 1.1 | 32 |
| | 27 | 23 (UDS) | - | - | 16.6 | - | - | - | - | - | - | 0.4 | 32 |
| | 36 | 24 (UDS) | - | - | 16.9 | - | - | - | - | - | - | 1.2 | 33 |
| | 40 | 8 (DS) | 20.1 | 2.66 | - | 12 | 68 | 20 | - | - | - | - | - |
| BH-3 | 1 | 9 (DS) | 4.7 | 2.69 | - | 0 | 93 | 7 | - | - | - | - | - |
| | 2 | 25 (UDS) | - | - | 16 | - | - | - | - | - | - | 1.8 | 27 |
| | 3 | 10 (DS) | 5.8 | 2.65 | - | 0 | 89 | 11 | - | - | - | - | - |
| | 4 | 26 (UDS) | - | - | 16.6 | - | - | - | - | - | - | 1.6 | 29 |
| | 5 | 11 (DS) | 4.8 | 2.66 | - | 0 | 93 | 7 | - | - | - | - | - |
| BH-4 | 1 | 12 (DS) | 10.1 | 2.67 | - | 0 | 92 | 8 | - | - | - | - | - |
| | 2 | 27 (UDS) | - | - | 16.1 | - | - | - | - | - | - | 1.6 | 28 |
| | 3 | 13 (DS) | 6.1 | 2.66 | - | 0 | 95 | 5 | - | - | - | - | - |
| | 4 | 86 (UDS) | - | - | 16.1 | - | - | - | - | - | - | 1.4 | 29 |
| | 5 | 14 (DS) | 4.7 | 2.67 | - | 1 | 92 | 7 | - | - | - | - | - |


BH3(MP)
BH1(MP)
BM1
BH4
DRY WATER STORAGE TANK
BM-1
WATER STORAGE TANK
BH2(MP)
BH4(MP)
BM-2
BH3
0
10
20
30
40
50
100m
N

## ECOS Ltd.; GEOTECHNICAL SERVICES

## BORE HOLE LOG

**Location:** WTP- Jhal
**Project:** WASA Master Plan
**Bore Hole No.:** 01
**Fig No.**
**Type of Boring:** Rotary
**Date Started:** 30-11-17
**Termination Depth:** 40 m
**Date Completed:** 02-12-17
**Ground Water Table:** 3 m
**Logger:** Umer

| Depth(m) | Sample Description | Classification Symbol | Legend | Sample Type | Moisture | Penetration Values | | | N-Values | N- Profile | Recovery | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 150 mm | 150 mm | 150 mm | | | SPT (cm) | CR % | RQD % | |
| 2 | clay | CL | 🟧 | DS | | 1 | 1 | 1 | 2 |  | 29 | | | |
| 4 | Silty clay | CL-ML | 🟧 | DS | | 1 | 1 | 2 | 3 | | 27 | | | |
| 6 | Silty sand | SM | ▒ | DS | | 5 | 9 | 9 | 18 | | 30 | | | |
| 8 | Fine graind sand | SW | ▒ | DS | | 8 | 11 | 12 | 23 | | 23 | | | |
| 10 | do | SW | ▒ | DS | | 8 | 10 | 14 | 24 | | 36 | | | |
| 12 | do | SW | ▒ | DS | | 9 | 11 | 12 | 23 | | 33 | | | |
| 14 | do | SW | ▒ | DS | | 10 | 14 | 19 | 33 | | 34 | | | |
| 16 | do | SW | ▒ | DS | | 18 | 22 | 23 | 45 | | 36 | | | |
| 18 | do | SW | ▒ | DS | | 10 | 12 | 15 | 27 | | 40 | | | |
| 20 | do | SW | ▒ | DS | | 17 | 20 | 18 | 38 | | 38 | | | |
| 22 | do | SW | ▒ | DS | | 12 | 10 | 10 | 20 | | 40 | | | |
| 24 | do | SW | ▒ | DS | | 12 | 12 | 21 | 33 | | 40 | | | |
| 26 | Silty clay | CL-ML | 🟧 | DS | | 9 | 13 | 27 | 40 | | 25 | | | |
| 28 | Silty sand | SM | ▒ | DS | | 10 | 14 | 27 | 41 | | 30 | | | |
| 30 | Medium graind sand | SW | ▒ | DS | | 11 | 19 | 20 | 39 | | | | | |
| 32 | do | SW | ▒ | DS | | 11 | 26 | 45 | 71 | | 27 | | | |
| 34 | do | SW | ▒ | DS | | 13 | 27 | 50 | 77 | | 35 | | | |
| 36 | Med-course sand | SW | ▒ | DS | | 14 | 28 | 50 | 78 | | 28 | | | |
| 38 | do | SW | ▒ | DS | | 20 | 26 | 38 | 64 | | | | | |
| 40 | do | SW | ▒ | DS | | 30 | 36 | 50 | 86 | | | | | |

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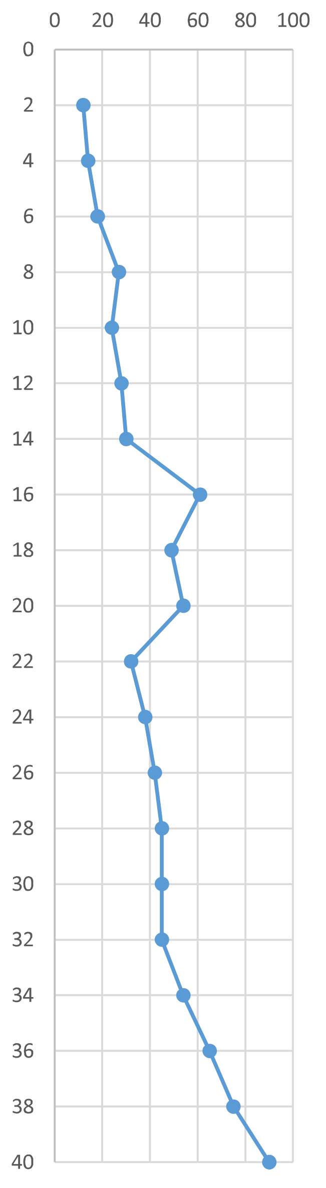
# ECOS Ltd.; GEOTECHNICAL SERVICES

## BORE HOLE LOG

| | |
|---|---|
| Location: WTP- Jhal | Project: WASA Master Plan |
| Bore Hole No.: 02 | Fig No. |
| Type of Boring: Rotary | Date Started: 03-12-2017 |
| Termination Depth: 40 m | Date Completed: 04-12-17 |
| Ground Water Table: 10 m | Logger: Umer |

| Depth(m) | Sample Description | Classification Symbol | Legend | Sample Type | Moisture | Penetration Values | | | N-Values | N- Profile | Recovery | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 150 mm | 150 mm | 150 mm | | | SPT (cm) | CR % | RQD % | |
| 2 | clay | CL | 🟧 | DS | | 5 | 5 | 7 | 12 | | 39 | | | |
| 4 | Silty clay | CL-ML | 🟧 | DS | | 5 | 6 | 8 | 14 | | 33 | | | |
| 6 | Silty sand | SM | ▒ | DS | | 6 | 7 | 11 | 18 | | 36 | | | |
| 8 | Fine graind sand | SW | ▒ | DS | | 8 | 13 | 14 | 27 | | 30 | | | |
| 10 | do | SW | ▒ | DS | | 9 | 11 | 13 | 24 | | 29 | | | |
| 12 | do | SW | ▒ | DS | | 9 | 11 | 16 | 28 | | 30 | | | |
| 14 | do | SW | ▒ | DS | | 10 | 14 | 16 | 30 | | 31 | | | |
| 16 | do | SW | ▒ | DS | | 25 | 30 | 31 | 61 | | 35 | | | |
| 18 | do | SW | ▒ | DS | | 20 | 24 | 25 | 49 | | 34 | | | |
| 20 | do | SW | ▒ | DS | | 17 | 25 | 29 | 54 | | 30 | | | |
| 22 | do | SW | ▒ | DS | | 15 | 16 | 16 | 32 | | 22 | | | |
| 24 | do | SW | ▒ | DS | | 16 | 18 | 20 | 38 | | 25 | | | |
| 26 | do | SW | ▒ | DS | | 8 | 17 | 25 | 42 | | 32 | | | |
| 28 | Clay | CL | 🟧 | DS | | 15 | 14 | 31 | 45 | | 27 | | | |
| 30 | Medium graind sand | SW | ▒ | DS | | 16 | 19 | 26 | 45 | | 39 | | | |
| 32 | do | SW | ▒ | DS | | 18 | 21 | 24 | 45 | | 28 | | | |
| 34 | do | SW | ▒ | DS | | 22 | 26 | 28 | 54 | | 38 | | | |
| 36 | Med-course sand | SW | ▒ | DS | | 25 | 30 | 35 | 65 | | 28 | | | |
| 38 | do | SW | ▒ | DS | | 30 | 45 | 40 | 75 | | 25 | | | |
| 40 | do | SW | ▒ | DS | | 40 | 40 | 50 | 90 | | 14 | | | |



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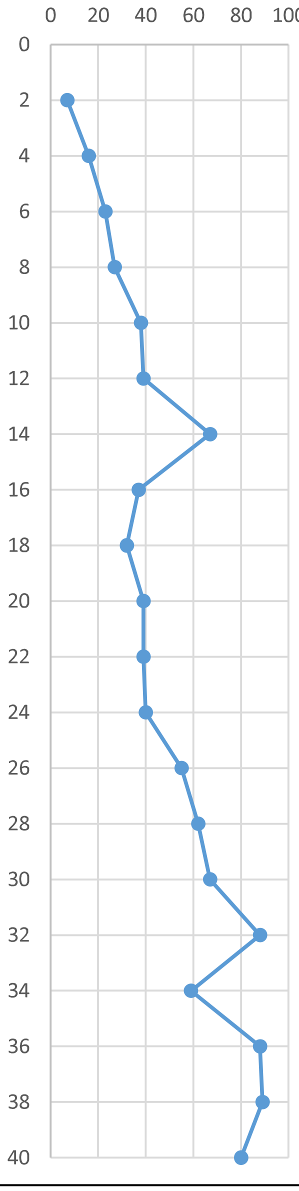
# ECOS Ltd.; GEOTECHNICAL SERVICES

## BORE HOLE LOG

| | |
|---|---|
| Location: WTP- Jhal | Project: WASA Master Plan |
| Bore Hole No.: 03 | Fig No. |
| Type of Boring: Rotary | Date Started: 05-12-2017 |
| Termination Depth: 40 m | Date Completed: 06-12-2017 |
| Ground Water Table: 20.6 m | Logger: Umer |

| Depth(m) | Sample Description | Classification Symbol | Legend | Sample Type | Moisture | Penetration Values | | | N-Values | N- Profile | Recovery | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 150 mm | 150 mm | 150 mm | | | SPT (cm) | CR % | RQD % | |
| 2 | clay | CL | 🟧 | DS | | 2 | 3 | 4 | 7 |  | 30 | | | |
| 4 | Silty Sand | SM | ▨ | DS | | 2 | 6 | 10 | 16 | | 20 | | | |
| 6 | Silty sand | SM | | DS | | 8 | 11 | 12 | 23 | | 32 | | | |
| 8 | Fine graind sand | SW | | DS | | 10 | 12 | 15 | 27 | | 29 | | | |
| 10 | do | SW | | DS | | 12 | 18 | 20 | 38 | | 27 | | | |
| 12 | do | SW | | DS | | 12 | 17 | 22 | 39 | | 29 | | | |
| 14 | do | SW | | DS | | 22 | 32 | 35 | 67 | | 35 | | | |
| 16 | do | SW | | DS | | 17 | 17 | 29 | 37 | | 35 | | | |
| 18 | do | SW | | DS | | 11 | 14 | 18 | 32 | | 32 | | | |
| 20 | do | SW | | DS | | 22 | 26 | 23 | 39 | | 32 | | | |
| 22 | do | SW | | DS | | 15 | 18 | 21 | 39 | | 32 | | | |
| 24 | do | SW | | DS | | 15 | 19 | 21 | 40 | | 30 | | | |
| 26 | do | SW | | DS | | 15 | 20 | 35 | 55 | | 28 | | | |
| 28 | Silty sand | SM | | DS | | 23 | 30 | 32 | 62 | | 35 | | | |
| 30 | Medium graind sand | SW | | DS | | 19 | 29 | 38 | 67 | | 33 | | | |
| 32 | do | SW | | DS | | 14 | 38 | 50 | 88 | | 30 | | | |
| 34 | do | SW | | DS | | 20 | 29 | 30 | 59 | | 32 | | | |
| 36 | Med-course sand | SW | | DS | | 11 | 36 | 50 | 88 | | 40 | | | |
| 38 | do | SW | | DS | | 20 | 39 | 50 | 89 | | 35 | | | |
| 40 | do | SW | | DS | | 12 | 30 | 50 | 80 | | 38 | | | |

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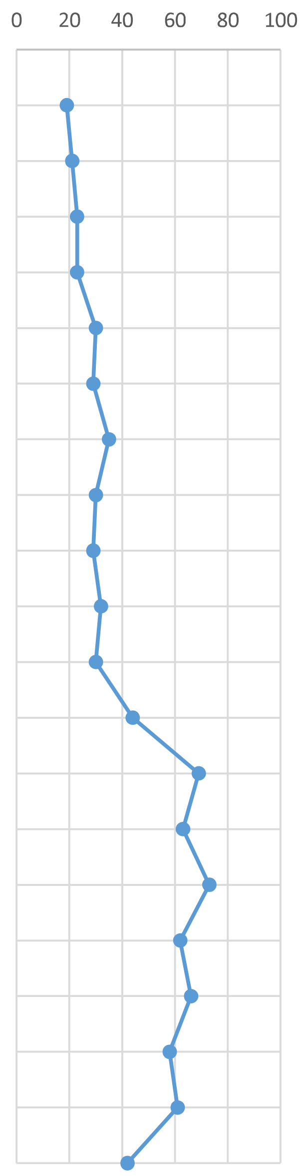
## ECOS Ltd.; GEOTECHNICAL SERVICES

| **BORE HOLE LOG** | | |
|---|---|---|
| | **Location: WTP- Jhal** | **Project: WASA Master Plan** |
| | **Bore Hole No.: 04** | **Fig No.** |
| | **Type of Boring: Rotary** | **Date Started: 07-12-2017** |
| | **Termination Depth: 40 m** | **Date Completed: 08-12-17** |
| | **Ground Water Table: 20.60 m** | **Logger: Umer** |

| **Depth(m)** | **Sample Description** | **Classification Symbol** | **Legend** | **Sample Type** | **Moisture** | **Penetration Values** | | | **N-Values** | **N- Profile** | **Recovery** | | | **Remarks** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | **150 mm** | **150 mm** | **150 mm** | | | **SPT (cm)** | **CR %** | **RQD %** | |
| 2 | clay | CL | 🟧 | DS | | 4 | 9 | 10 | 19 |  | 35 | | | |
| 4 | Silty clay | CL | 🟧 | DS | | 5 | 9 | 12 | 21 | | 39 | | | |
| 6 | Silty sand | SM | ▒ | DS | | 10 | 10 | 13 | 23 | | 33 | | | |
| 8 | Fine graind sand | SW | ▒ | DS | | 7 | 11 | 12 | 23 | | 30 | | | |
| 10 | do | SW | ▒ | DS | | 9 | 14 | 16 | 30 | | 33 | | | |
| 12 | do | SW | ▒ | DS | | 11 | 14 | 15 | 29 | | 33 | | | |
| 14 | do | SW | ▒ | DS | | 9 | 16 | 19 | 35 | | 28 | | | |
| 16 | do | SW | ▒ | DS | | 13 | 15 | 15 | 30 | | 34 | | | |
| 18 | do | SW | ▒ | DS | | 11 | 13 | 16 | 29 | | 38 | | | |
| 20 | do | SW | ▒ | DS | | 17 | 17 | 15 | 32 | | 28 | | | |
| 22 | do | SW | ▒ | DS | | 11 | 14 | 16 | 30 | | 32 | | | |
| 24 | do | SW | ▒ | DS | | 18 | 21 | 23 | 44 | | 35 | | | |
| 26 | Silty clay | CL | 🟧 | DS | | 10 | 35 | 34 | 69 | | 31 | | | |
| 28 | Silty sand | SM | ▒ | DS | | 24 | 27 | 36 | 63 | | 32 | | | |
| 30 | Medium graind sand | SW | ▒ | DS | | 25 | 34 | 39 | 73 | | 28 | | | |
| 32 | do | SW | ▒ | DS | | 11 | 27 | 35 | 62 | | 25 | | | |
| 34 | do | SW | ▒ | DS | | 25 | 29 | 37 | 66 | | 33 | | | |
| 36 | Med-course sand | SW | ▒ | DS | | 27 | 30 | 28 | 58 | | 25 | | | |
| 38 | do | SW | ▒ | DS | | 25 | 30 | 31 | 61 | | 33 | | | |
| 40 | do | SW | ▒ | DS | | 19 | 18 | 24 | 42 | | 34 | | | |

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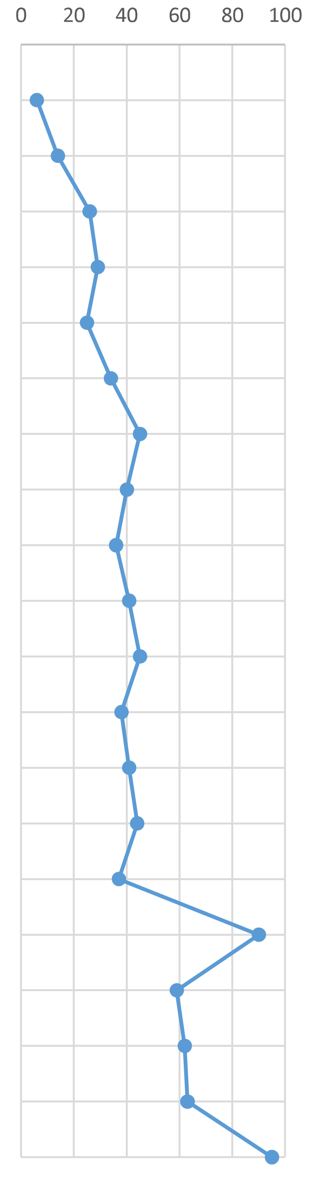
## ECOS Ltd.; GEOTECHNICAL SERVICES

| **BORE HOLE LOG** | | |
|---|---|---|
| | **Location: Abdullah Pur OHR** | **Project: WASA Master Plan** |
| | **Bore Hole No.: 05** | **Fig No.** |
| | **Type of Boring: Rotary** | **Date Started: 10-12-2017** |
| | **Termination Depth: 40 m** | **Date Completed: 11-12-2017** |
| | **Ground Water Table: 19 m** | **Logger: Umer** |

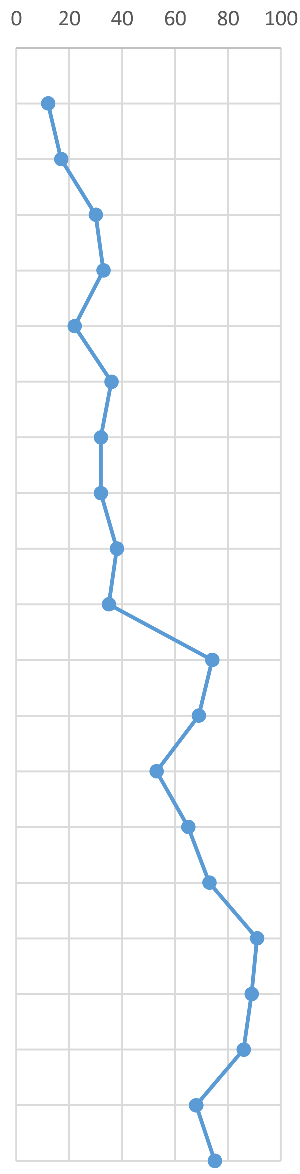
| Depth(m) | Sample Description | Classification Symbol | Legend | Sample Type | Moisture | Penetration Values | | | N-Values | N- Profile | Recovery | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 150 mm | 150 mm | 150 mm | | | SPT (cm) | CR % | RQD % | |
| 2 | Silty clay | CL-ML | 🟧 | DS | | 3 | 2 | 4 | 6 |  | 30 | | | |
| 4 | Silty Sand | SM | ▒ | DS | | 5 | 6 | 8 | 14 | | 34 | | | |
| 6 | Silty sand | SM | ▒ | DS | | 8 | 12 | 14 | 26 | | 32 | | | |
| 8 | Fine graind sand | SW | ▒ | DS | | 10 | 13 | 16 | 29 | | 34 | | | |
| 10 | do | SW | ▒ | DS | | 11 | 13 | 12 | 25 | | 30 | | | |
| 12 | do | SW | ▒ | DS | | 13 | 15 | 19 | 34 | | 29 | | | |
| 14 | do | SW | ▒ | DS | | 20 | 22 | 23 | 45 | | 30 | | | |
| 16 | Claye Silt | ML | ▓ | DS | | 16 | 19 | 21 | 40 | | 35 | | | |
| 18 | Fine graind sand | SW | ▒ | DS | | 10 | 17 | 19 | 36 | | 35 | | | |
| 20 | do | SW | ▒ | DS | | 7 | 14 | 27 | 41 | | 33 | | | |
| 22 | do | SW | ▒ | DS | | 9 | 15 | 30 | 45 | | 22 | | | |
| 24 | do | SW | ▒ | DS | | 14 | 22 | 16 | 38 | | 38 | | | |
| 26 | Silty clay | CL-ML | 🟧 | DS | | 4 | 15 | 26 | 41 | | 25 | | | |
| 28 | Silty sand | SM | ▒ | DS | | 18 | 20 | 24 | 44 | | 34 | | | |
| 30 | Medium graind sand | SW | ▒ | DS | | 14 | 15 | 22 | 37 | | 29 | | | |
| 32 | do | SW | ▒ | DS | | 13 | 40 | 50 | 90 | | 25 | | | |
| 34 | do | SW | ▒ | DS | | 10 | 20 | 39 | 59 | | 29 | | | |
| 36 | Med-course sand | SW | ▒ | DS | | 12 | 33 | 29 | 62 | | 32 | | | |
| 38 | do | SW | ▒ | DS | | 19 | 26 | 33 | 63 | | 28 | | | |
| 40 | do | SW | ▒ | DS | | 30 | 45 | 50 | 95 | | 32 | | | |

Checked By: ______________________________

# ECOS Ltd.; GEOTECHNICAL SERVICES

## BORE HOLE LOG

**Location:** Madina  Town OHR NO.2
**Project:** WASA Master Plan
**Bore Hole No.:** 06
**Fig No.**
**Type of Boring:** Rotary
**Date Started:** 13-12-2017
**Termination Depth:** 40 m
**Date Completed:** 14-12-2017
**Ground Water Table:** 17
**Logger:** Umer

| Depth(m) | Sample Description | Classification Symbol | Legend | Sample Type | Moisture | Penetration Values | | | N-Values | N- Profile | Recovery | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 150 mm | 150 mm | 150 mm | | | SPT (cm) | CR % | RQD % | |
| 2 | clay | CL | 🟧 | DS | | 4 | 5 | 7 | 12 |  | 25 | | | |
| 4 | Clayey Silt | ML | ▩ | DS | | 5 | 7 | 10 | 17 | | 30 | | | |
| 6 | Silty sand | SM | ▒ | DS | | 11 | 14 | 16 | 30 | | 35 | | | |
| 8 | Silty sand | SM | | DS | | 10 | 16 | 17 | 33 | | 22 | | | |
| 10 | Fine graind sand | SW | | DS | | 9 | 10 | 12 | 22 | | 31 | | | |
| 12 | do | SW | | DS | | 15 | 15 | 21 | 36 | | 33 | | | |
| 14 | do | SW | | DS | | 11 | 14 | 18 | 32 | | 28 | | | |
| 16 | do | SW | | DS | | 15 | 10 | 22 | 32 | | 30 | | | |
| 18 | do | SW | | DS | | 15 | 17 | 21 | 38 | | 30 | | | |
| 20 | do | SW | | DS | | 13 | 17 | 18 | 35 | | 28 | | | |
| 22 | do | SW | | DS | | 9 | 29 | 45 | 74 | | 27 | | | |
| 24 | do | SW | | DS | | 22 | 34 | 35 | 69 | | 33 | | | |
| 26 | do | SW | | DS | | 12 | 18 | 35 | 53 | | 27 | | | |
| 28 | do | SW | | DS | | 18 | 28 | 37 | 65 | | 27 | | | |
| 30 | Medium graind sand | SW | | DS | | 20 | 31 | 42 | 73 | | 35 | | | |
| 32 | do | SW | | DS | | 30 | 41 | 50 | 91 | | 35 | | | |
| 34 | do | SW | | DS | | 29 | 42 | 47 | 89 | | 48 | | | |
| 36 | Med-course sand | SW | | DS | | 30 | 37 | 49 | 86 | | 28 | | | |
| 38 | do | SW | | DS | | 30 | 33 | 35 | 68 | | 26 | | | |
| 40 | do | SW | | DS | | 32 | 35 | 40 | 75 | | 22 | | | |

Checked By: ______________________________

**University of Engineering & Technology, Lahore**
**Department of Civil Engineering**
**Geotechnical Engineering Laboratory**

# SUMMARY OF THE TEST RESULTS

**Project:** Geotechnical Investigation for WASA Master Plan, Faisalabad

**Client:** M/S ECOS Ltd

| BH/ TP No. | Sample No | Depth (m) | NMC (%) | Bulk Density (kN/m$^3$) | Specific Gravity $G_s$ |
|---|---|---|---|---|---|
| BH-01 | 1 (UDS) | 1 | 21.68 | 19.21 | 2.7 |
| | 2 (UDS) | 7 | 25.05 | 18.64 | 2.67 |
| | 3 (UDS) | 14 | 17.96 | 14.55 | 2.65 |
| | 4 (UDS) | 19 | 18.27 | 16.08 | 2.67 |
| | 5 (UDS) | 25 | 24.24 | 20.55 | 2.65 |
| | 6 (UDS) | 30 | 23.88 | 15.74 | 2.66 |
| | 7 (UDS) | 35 | 25.17 | 13.48 | 2.69 |
| | 8 (UDS) | 40 | 17.67 | 15.90 | 2.68 |
| BH-02 | 9 (UDS) | 3 | 9.61 | 20.48 | 2.7 |
| | 10 (UDS) | 7 | 7.50 | 18.93 | 2.67 |
| | 11 (UDS) | 15 | 7.32 | 16.97 | 2.67 |
| | 12 (UDS) | 20 | 4.32 | 16.31 | 2.66 |
| | 13 (UDS) | 25 | 17.34 | 19.79 | 2.65 |
| | 14 (UDS) | 30 | 27.66 | 18.30 | 2.67 |
| | 15 (UDS) | 35 | 14.41 | 12.48 | 2.67 |
| | 16 (UDS) | 40 | 19.27 | 18.44 | 2.65 |

Prepared by:

Director

Checked by:

# University of Engineering & Technology, Lahore
## Department of Civil Engineering
## Geotechnical Engineering Laboratory

## SUMMARY OF THE TEST RESULTS

**Project:** Geotechnical Investigation for WASA Master Plan, Faisalabad

**Client:** M/S ECOS Ltd

| BH/ TP No. | Sample No | Depth (m) | NMC (%) | Bulk Density (kN/m$^3$) | Specific Gravity $G_s$ |
|---|---|---|---|---|---|
| BH-03 | 17 (UDS) | 5 | 2.37 | 16.54 | 2.66 |
| | 18 (UDS) | 11 | 7.22 | 20.71 | 2.67 |
| | 19 (UDS) | 15 | 9.19 | 17.99 | 2.67 |
| | 20 (UDS) | 21 | 20.48 | 17.94 | 2.66 |
| | 21 (UDS) | 25 | 21.92 | 20.86 | 2.67 |
| | 22 (UDS) | 31 | 26.52 | 16.14 | 2.66 |
| | 23 (UDS) | 35 | 24.92 | 20.47 | 2.65 |
| | 24 (SPT) | 40 | 16.53 | | 2.65 |
| BH-04 | 25 (UDS) | 5 | 4.32 | 16.20 | 2.67 |
| | 26 (UDS) | 11 | 6.41 | 17.78 | 2.67 |
| | 27 (UDS) | 15 | 12.36 | 17.35 | 2.67 |
| | 28 (UDS) | 21 | 9.82 | 26.16 | 2.66 |
| | 29 (UDS) | 25 | 17.35 | 19.44 | 2.65 |
| | 30 (UDS) | 31 | 22.79 | 18.65 | 2.67 |
| | 31 (SPT) | 36 | 32.67 | | 2.66 |
| | 32 (SPT) | 40 | 22.86 | | 2.65 |

Prepared by:

Director

Checked by:

**University of Engineering & Technology, Lahore**
**Department of Civil Engineering**
**Geotechnical Engineering Laboratory**

## SUMMARY OF THE TEST RESULTS

**Project:** Geotechnical Investigation for WASA Master Plan, Faisalabad

**Client:** M/S ECOS Ltd

| BH/ TP No. | Sample No | Depth (m) | NMC (%) | Bulk Density (kN/m$^3$) | Specific Gravity $G_s$ |
|---|---|---|---|---|---|
| BH-05 | 33 (UDS) | 5 | 9.23 | 17.74 | 2.65 |
| | 34 (UDS) | 11 | 7.28 | 16.47 | 2.65 |
| | 35 (UDS) | 15 | 15.10 | 16.46 | 2.66 |
| | 36 (UDS) | 21 | 23.43 | 18.48 | 2.67 |
| | 37 (UDS) | 25 | 24.64 | 17.79 | 2.67 |
| | 38 (UDS) | 31 | 23.30 | 17.50 | 2.67 |
| | 39 (SPT) | 36 | 19.62 | | 2.67 |
| | 40 (SPT) | 40 | 20.11 | | 2.67 |
| BH-06 | 41 (UDS) | 1.5 | 20.39 | 17.17 | 2.70 |
| | 42 (UDS) | 5 | 21.26 | 16.61 | 2.65 |
| | 43 (UDS) | 11 | 7.78 | 15.98 | 2.67 |
| | 44 (UDS) | 15 | 9.63 | 18.34 | 2.68 |
| | 45 (UDS) | 21 | 6.79 | 16.12 | 2.67 |
| | 46 (UDS) | 25 | 18.72 | 18.05 | 2.66 |
| | 47 (SPT) | 32 | 20.46 | | 2.65 |
| | 48 (SPT) | 36 | 22.78 | | 2.67 |

Prepared by:

Checked by:

# Appendix7 References

## (3) Results on Excavation and Underground Infrastructure Observation Survey

### Survey List（Excavation and underground structure observation survey）

| Sr.# | MAP # | Pit/Chamber Name | Excavation date | Pipe to be identified | Actual identified pipe | Road | Pavement | Notes |
|---|---|---|---|---|---|---|---|---|
| 1 | 6 | ⑤-Ⅱ-1-1 | 27-Jun | Installation point of a valve on Ex. Distribution Main (DN250) | PVC DN100, DP=1.8m<br>PVC DN100, DP=1.9m | Main Rd (Susan Rd) | No pavement (green belt) | |
| 2 | 3 | ⑥-PM-7 | 28-Jun | Intersection point of Ex. Distribution Main (DN300) and proposed Distribution Primary Main (DN450) | CIP DN250, DP=1.43m<br>CIP DN250, DP=1.43m | Main Rd (Susan Rd) | No pavement (green belt) | |
| 3 | 9 | ⑥-EX-01 | 28-Jun | Intersection pointof Ex.Distribution Main (DN600) and proposed Interconnecting Main. | AC DN600, DP=1.65m | Inside Old JK WTP | No pavement | |
| 4 | 9 | ⑥-EX-02 | 29-Jun | Intersection point of Ex.Distribution Main (DN600) and proposed Interconnecting Main. | No pipe | Inside Old JK WTP | No pavement | |
| 5 | 7 | ⑥-TM-3 | 1-Jul | Intersection point of Ex. Distribution Main (DN250) and proposed Transmission Main (DN450) | AC DN250, DP=1.52m | Main Rd (Green Belt Rd) | No pavement (shoulder) | |
| 6 | 7 | ⑥-PM-9 | 1-Jul | Intersection point of Ex. Distribution Main (DN250) and proposed Distribution Primary Main (DN450) | AC DN250, DP=1.18m | Main Rd (Green Belt Rd) | Brick (shoulder) | |
| 7 | 11 | ②-Ⅱ-3-1 | 2-Jul | Point of cutting or installation of a valve on Ex. Distribution Main (DN150) | AC DN200, DP=1.1m | Town Rd (Madina Town) | No pavement (shoulder) | |
| 8 | 12 | ⑥-PM-13 | 2-Jul | Intersection point of Ex. Distribution Main (DN200) and proposed Distribution Primary Main (DN300) | AC DN200, DP=1.43m<br>CIP DN75, DP=1.43m | Town Rd (Madina Town) | Asphalt | |
| 9 | 15 | ⑥-PM-12 | 3-Jul | Intersection point of Ex. Distribution Main (DN300) and proposed Distribution Primary Main (DN300) | Steel DN300, DP=0.23m<br>Steel DN200, DP=0.23m | Main Rd (Jaranwala Rd) | Asphalt | |
| 10 | 3 | ⑥-TM-2 | 4-Jul | Intersection point of Ex. Distribution Main (DN600) and proposed Transmission Main (DN450) | No pipe | Main Rd (Service road of Canal Expy) | Asphalt | |
| 11 | 11 | ①-Ⅱ-3-1 | 13-Jul | Connecting point of Ex. Distribution Main (DN100) and proposed Distribution Secondary Main (DN200) | No pipe | Town Rd (Madina Town) | No pavement (shoulder) | |
| 12 | 11 | ①-Ⅱ-3-1A | 13-Jul | Connecting point of Ex. Distribution Main (DN100) and proposed Distribution Secondary Main (DN200) | AC DN150, DP=1.25m | Town Rd (Madina Town) | No pavement (shoulder) | |
| 13 | 2 | ①-Ⅰ-1-1 | 14-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN200) | AC DN100, DP=1.50m | Town Rd (Abdullar Pur) | Concrete | |
| 14 | 2 | ①-Ⅰ-2-2 | 15-Jul | Connecting point of Ex. Distribution Main (DN100) and proposed Distribution Secondary Main (DN150) | AC DN100, DP=1.27m | Town Rd (Abdullar Pur) | Asphalt | |
| 15 | 2 | ④-Ⅰ-1-2 | 15-Jul | Cutting point of Ex. Distribution Main (DN150) | No pipe | Town Rd (Abdullar Pur) | Asphalt | |
| 16 | 7 | ①-Ⅱ-1-6 | 16-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | AC DN250, DP=1.75m<br>CIP DN75, DP=1.75m | Main Rd (Susan Rd) | No pavement (green belt) | |
| 17 | 7 | ①-Ⅱ-1-5 | 16-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | AC DN250, DP=1.24m<br>CIP DN150, DP=1.24m | Main Rd (Susan Rd) | No pavement (green belt) | |
| 18 | 6 | ①-Ⅱ-1-1 | 17-Jul | Connecting point of Ex. Distribution Main (DN100) and proposed Distribution Secondary Main (DN150) | AC DN100, DP=1.5m (new)<br>AC DN50, DP=1.2m (old) | Town Rd (Madina Town) | Tile, Asphalt | |
| 19 | 6 | ①-Ⅱ-1-2 | 17-Jul | Connecting point of Ex. Distribution Main (DN100) and proposed Distribution Secondary Main (DN150) | AC DN100, DP=0.57m<br>AC DN100, DP=0.57m | Town Rd (Madina Town) | Asphalt | |
| 20 | 11 | ⑤-Ⅱ-4-1 | 18-Jul | Installation point of a valve to Ex. Distribution Main (DN200) | AC DN200, DP=1.74m | Town Rd (Madina Town) | Asphalt | |
| 21 | 12 | ①-Ⅱ-4-3 | 18-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | PVC DN75, DP=1.10m | Town Rd (Madina Town) | Asphalt | |
| 22 | 7 | ①-Ⅱ-3-2 | 19-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | PVC DN75, DP=0.70m | Town Rd (Madina Town) | Asphalt | |
| 23 | 3 | ①-Ⅱ-1-8 | 19-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | PVC DN100, DP=1.00m<br>PVC DN75, DP=1.00m | Town Rd (Madina Town) | Asphalt | |
| 24 | 3 | ①-Ⅱ-1-7 | 19-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | PVC DN75, DP=0.90m<br>PVC DN75, DP=0.90m | Town Rd (Madina Town) | Asphalt | |

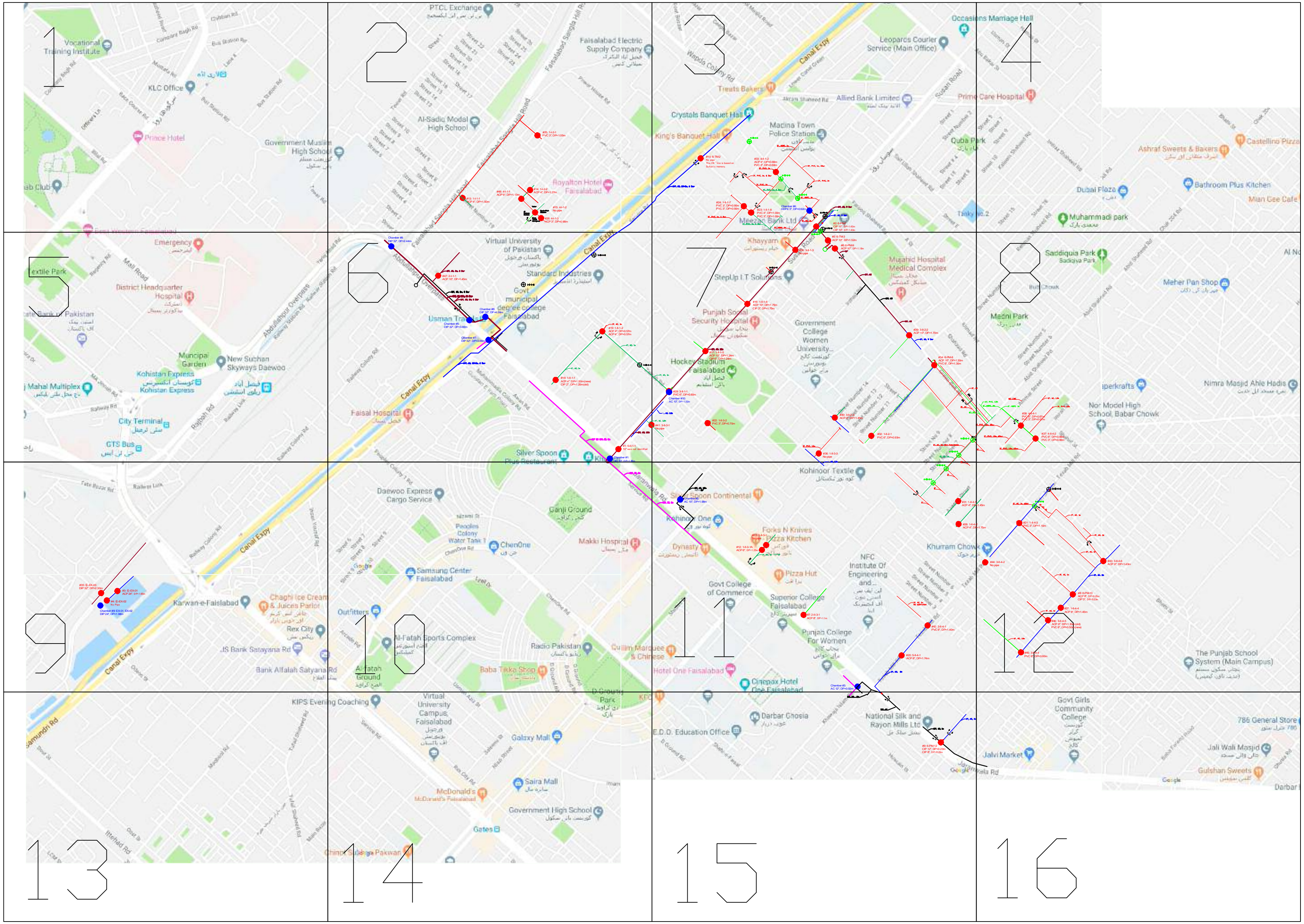
| Sr.# | MAP # | Pit/Chamber Name | Excavation date | Pipe to be identified | Actual identified pipe | Road | Pavement | Notes |
|---|---|---|---|---|---|---|---|---|
| 25 | 2 | ①-I-2-1 | 21-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | PVC DN75, DP=1.05m | Town Rd (Abdullar Pur) | Concrete, Asphalt | |
| 26 | 2 | ④-I-1-3 | 21-Jul | Cutting point of Ex. Distribution Main (DN75) | ACP DN75, DP=0.96m | Town Rd (Abdullar Pur) | Concrete, Asphalt | |
| 27 | 12 | ①-II-4-4 | 22-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN200) | ACP DN200, DP=1.45m | Town Rd (Madina Town) | Asphalt | |
| 28 | 11 | ①-II-4-2 | 22-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | ACP DN100, DP=1.75m | Town Rd (Madina Town) | Tile (shoulder) | |
| 29 | 7 | ③-II-1-1 | 23-Jul | Cutting point of Ex. Distribution Main (DN100) | PVC DN150, DP=0.80m | Main Rd (Susan Rd) | No pavement (green belt) | Count as 2 pits because of more than 3m2 of excavation area |
| 30 | 7 | ③-II-1-3 | 23-Jul | Cutting point of Ex. Distribution Main (DN75) | No pipe | Main Rd (Susan Rd) | No pavement (green belt) | |
| 31 | 11 | ①-II-4-1 | 24-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | ACP DN100, DP=1.45m | Town Rd (Madina Town) | Asphalt | |
| 32 | 7 | ①-II-2-1 | 24-Jul | Connecting point of Ex. Distribution Main (DN100) and proposed Distribution Secondary Main (DN150) | PVC DN150, DP=0.93m | Town Rd (Madina Town) | Asphalt | |
| 33 | 3 | ④-II-1-2 | 26-Jul | Cutting point of Ex. Distribution Main (DN75) | ACP DN100, DP=0.68m<br>PVC DN75, DP0.68m | Town Rd (Madina Town) | Asphalt | |
| 34 | 7 | ⑥-PM-8 | 26-Jul | Intersection point of Ex. Distribution Main (DN250) and proposed Distribution Primary Main (DN400) | ACP DN250, DP=1.30m<br>PVC DN150, DP01.30m | Main Rd (Green Belt Rd) | No pavement (shoulder) | |
| 35 | 9 | ⑥-EX-03 | 27-Jul | Connecting point of Ex.Arterial Main (DN800) and proposed Interconnecting Main. | DIP DN800, DP=2.30m | Town Rd (Jhal) | Asphalt | |
| 36 | 7 | ①-II-3-3 | 27-Jul | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | No pipe | Town Rd (Madina Town) | Tile | |
| 37 | 8 | ④-II-4-2 | 28-Jul | Cutting point of Ex. Distribution Main (DN75) | PVC DN150, DP=0.66m<br>PVC DN75, DP=0.66m | Town Rd (Madina Town) | Asphalt | |
| 38 | 8 | ④-II-4-1 | 28-Jul | Cutting point of Ex. Distribution Main (DN75) | PVC DN150, DP=0.67m<br>PVC DN75, DP=0.67m | Town Rd (Madina Town) | Asphalt | |
| 39 | 7 | ③-II-2-2 | 29-Jul | Cutting point of Ex. Distribution Main (DN150) | ACP DN250, DP=1.70m | Main Rd (Green Belt Rd) | No pavement (shoulder) | |
| 40 | 7 | ③-II-2-3 | 29-Jul | Cutting point of Ex. Distribution Main (DN150) | ACP DN100, DP=1.45m | Town Rd (Madina Town) | Brick (shoulder) | Count as 2 pits because of more than 3m2 of excavation area |
| 41 | 7 | ③-II-3-1 | 30-Jul | Cutting point of Ex. Distribution Main (DN200) | No pipe | Main Rd (Susan Rd) | Tile, Asphalt | |
| 42 | 11 | ③-II-4-1 | 31-Jul | Cutting point of Ex. Distribution Main (DN75) | PVC DN200, DP=1.40m | Town Rd (Madina Town) | Asphalt | |
| 43 | 12 | ③-II-4-6 | 31-Jul | Cutting point of Ex. Distribution Main (DN75) | ACP DN200, DP=1.43m | Town Rd (Madina Town) | Asphalt | |
| 44 | 12 | ③-II-4-2 | 1-Aug | Cutting point of Ex. Distribution Main (DN75) | No pipe | Town Rd (Madina Town) | Asphalt | |
| 45 | 12 | ③-II-4-4 | 1-Aug | Cutting point of Ex. Distribution Main (DN150) | PVC DN200, DP=0.60m | Town Rd (Madina Town) | Asphalt | |
| 46 | 12 | ③-II-4-5 | 1-Aug | Cutting point of Ex. Distribution Main (DN75) | ACP DN200, DP=1.30m (OLD)<br>PVC DN200, DP=0.50m (NEW) | Town Rd (Madina Town) | Asphalt | |
| 47 | 6 | ②-I-1-1 | 2-Aug | Installation point of a valve to Ex. Distribution Main (DN250) | ACP DN250, DP=1.45m | Main Rd (Faisalabad Sangla Hill Rd) | Asphalt | |
| 48 | 2 | ④-I-1-1 | 2-Aug | Cutting point of Ex. Distribution Main (DN100) | ACP DN150, DP=1.13m | Town Rd (Abdullar Pur) | Concrete, Asphalt | |
| **Valve chambers surveyed** | | | | | | | | |
| Chamber # 1 | 6 | ⑤-II-1-1 | - | Installation point of a valve on Ex. Distribution Main (DN250) | AC DN250, DP=1.98m | Main Rd (Susan Rd) | - | |
| Chamber # 2 | 11 | ⑥-PM-10 | - | Intersection point of Ex.Distribution Main (DN300) and proposed Distribution Primary Main (DN400) | DN250, DP=1.98m | Main Rd (Jaranwala Rd) | - | |
| Chamber # 3 | 11 | ⑥-PM-11 | - | Intersection point of Ex.Arterial Main (DN500) and proposed Distribution Primary Main (DN300) | AC DN300, DP=0.92m | Main Rd (Jaranwala Rd) | - | |

| Sr.# | MAP # | Pit/Chamber Name | Excavation date | Pipe to be identified | Actual identified pipe | Road | Pavement | Notes |
|---|---|---|---|---|---|---|---|---|
| Chamber # 4 | 3 | ④-Ⅱ-1-5 | - | Cutting point of Ex. Distribution Main (DN75) | DN75, DP=0.92m | Town Rd (Madina Town) | - | |
| Chamber # 5 | 6 | ⑥-PM-4 | - | Intersection point of Ex.Arterial Main (DN800) and proposed Distribution Primary Main (DN300) | DIP DN800, DP=3.66m | Main Rd (Canal Expy) | - | |
| Chamber # 6 | 6 | ⑥-PM-5 | - | Intersection point of Ex.Arterial Main (DN600) and proposed Distribution Primary Main (DN300) | DIP DN800, DP=4.58m | Main Rd (Canal Expy) | - | |
| Chamber # 7 | 6 | ⑥-PM-6 | - | Intersection point of Ex.Arterial Main (DN800) and proposed Distribution Primary Main (DN300) | DIP DN800, DP=3.66m | Main Rd (Jaranwala Rd) | - | |
| Chamber # 8 | 6 | ⑥-TM-1 /<br>⑥-PM-1 | - | Intersection point of Ex.Arterial Main (DN800) and proposed Transmission Main (DN450) and proposed Distribution Primary Main (DN300) | DIP DN800, DP=2.44m | Main Rd (Faisalabad Sangla Hill Rd) | - | |
| Chamber # 9 | 9 | ⑥-EX-01 /<br>⑥-EX-02 | - | Intersection point of Ex.Distribution Main (DN600) and proposed Interconnecting Main. | DIP DN600, DP=1.98m | Inside Old JK WTP | - | |
| Chamber # 10 | 7 | ③-Ⅱ-1-1 | - | Cutting point of Ex. Distribution Main (DN100) | AC DN250, DP=1.52m<br>AC DN150, DP=1.52m | Main Rd (Susan Rd) | - | |
| **No need to be excavated** | | | | | | | | |
| - | 3 | ⑥-PM-2 | - | Intersection point of Ex. Distribution Main (DN250) and proposed Distribution Primary Main (DN400) | - | Main Rd (Susan Rd) | - | |
| - | 3 | ⑥-PM-3 | - | Intersection point of Ex. Distribution Main (DN300) and proposed Distribution Primary Main (DN400) | - | Main Rd (Susan Rd) | - | |
| - | 12 | ⑤-Ⅱ-4-2 | - | Installation point of a valve to Ex. Distribution Main (DN200) | - | Town Rd (Madina Town) | - | |
| - | 6 | ①-Ⅰ-1-2 | - | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN200) | - | Main Rd (Canal Expy) | - | |
| - | 6 | ①-Ⅱ-1-3 | - | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | - | Town Rd (Madina Town) | - | |
| - | 6 | ①-Ⅱ-1-4 | - | Connecting point of Ex. Distribution Main (DN75) and proposed Distribution Secondary Main (DN150) | - | Town Rd (Madina Town) | - | |
| **Cannot be excavated** | | | | | | | | |
| - | 3 | ④-Ⅱ-1-1 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 3 | ④-Ⅱ-1-3 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 3 | ④-Ⅱ-1-4 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 7 | ③-Ⅱ-1-2 | - | Cutting point of Ex. Distribution Main (DN75) | - | Main Rd (Susan Rd) | - | |
| - | 3 | ③-Ⅱ-2-1 | - | Cutting point of Ex. Distribution Main (DN200) | - | Main Rd (Susan Rd) | - | |
| - | 11 | ④-Ⅱ-2-1 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 11 | ④-Ⅱ-2-2 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 7 | ④-Ⅱ-2-3 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 7 | ④-Ⅱ-2-4 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |
| - | 12 | ③-Ⅱ-4-3 | - | Cutting point of Ex. Distribution Main (DN75) | - | Town Rd (Madina Town) | - | |

Notes:

① To identify actual connecting point of new distribution secondary main and existing distribution tertiary main.
② To identify actual isolation point (installing valve or cutting & plugging) between existing distribution primary main (to be used) and existing distribution secondary main (not to be used).
③ To identify actual isolation point (installing valve or cutting & plugging) between existing distribution secondary main and existing distribution tertiary main.
④ To identify actual isolation point (installing valve or cutting & plugging) of existing distribution tertiary main at boundary of DMA.
⑤ To identify actual valve installation point on existing primary or secondary main to isolate distribution area.
⑥ To identify actual location (alignment and depth) of existing underground infrastructure (big water supply pipe such as arterial main and primary main, sewerage pipe, drainage channel, commutation cable, etc.) in order to define alignment and depth of new transmission main and new distribution primary main.

App 7(3)-4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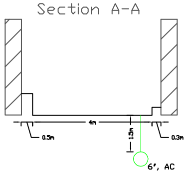
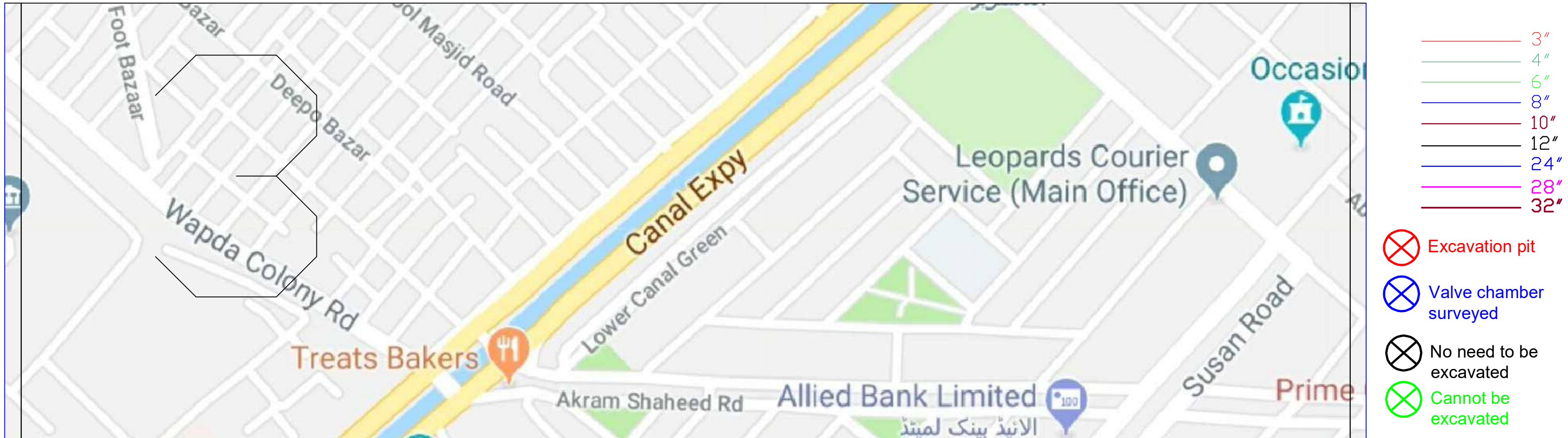
16
Vocational Training Institute
KLC Office
Prince Hotel
Government Muslim High School
PTCL Exchange
Al-Sadiq Model High School
Faisalabad Electric Supply Company
Royalton Hotel Faisalabad
Canal Expy
Wapda Colony Rd
Treats Bakers
Crystals Banquet Hall
King's Banquet Hall
Madina Town Police Station
Allied Bank Limited
Occasions Marriage Hall
Leopards Courier Service (Main Office)
Prime Care Hospital
Quba Park
Meezan Bank Ltd
Ashraf Sweets & Bakers
Castellino Pizza
Bathroom Plus Kitchen
Dubai Plaza
Muhammadi park
Emergency
District Headquarter Hospital
Textile Park
Muncipal Garden
New Suchan Skyways Daewoo
Kohistan Express
City Terminal
Mahal Multiplex
Virtual University of Pakistan
Standard Industries
Govt. municipal degree college Faisalabad
Usman Travel
Faisal Hospital
Silver Spoon Plus Restaurant
Khayyam
StepUp I.T Solutions
Punjab Social Security Hospital
Government College Women University
Hockey Stadium Faisalabad
Mujahid Hospital Medical Complex
Saddiquia Park
Madni Park
Meher Pan Shop
Nimra Masjid Ahle Hadis
Nor Model High School, Babar Chowk
Daewoo Express Cargo Service
Ganji Ground
Makki Hospital
ChenOne
Samsung Center Faisalabad
Kohinoor Textile
Silver Spoon Continental
Kohinoor One
Forks N Knives
Pizza Kitchen
Dynasty
Pizza Hut
NFC Institute Of Engineering and...
Govt College of Commerce
Superior College Faisalabad
Punjab College For Women
Khurram Chowk
Karwan-e-Faisalabad
Chaghi Ice Cream & Juices Parlor
Rex City
JS Bank Satayana Rd
Bank Alfalah Satyana Rd
Outfitters
Al-Fatah Sports Complex
Al-Fatah Ground
Radio Pakistan
Baba Tikka Shop
Quaid Marquee & Chinese
Hotel One Faisalabad
Cinepax Hotel One Faisalabad
The Punjab School System (Main Campus)
KIPS Evening Coaching
Virtual University Campus Faisalabad
Galaxy Mall
Saira Mall
McDonald's
Government High School
Gates
D Ground Park
E.D.D. Education Office
Darbar Ghosia
National Silk and Rayon Mills Ltd
Govt Girls Community College
Jalvi Market
786 General Store
Jali Wali Masjid
Gulshan Sweets
Samundri Rd
Jaranwala Rd

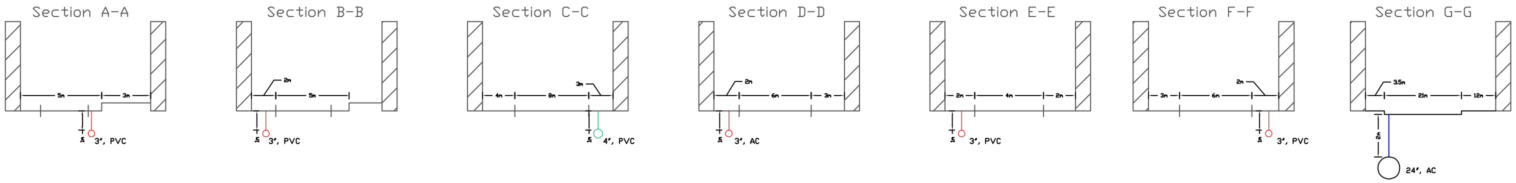
Section A-A



Cross Section

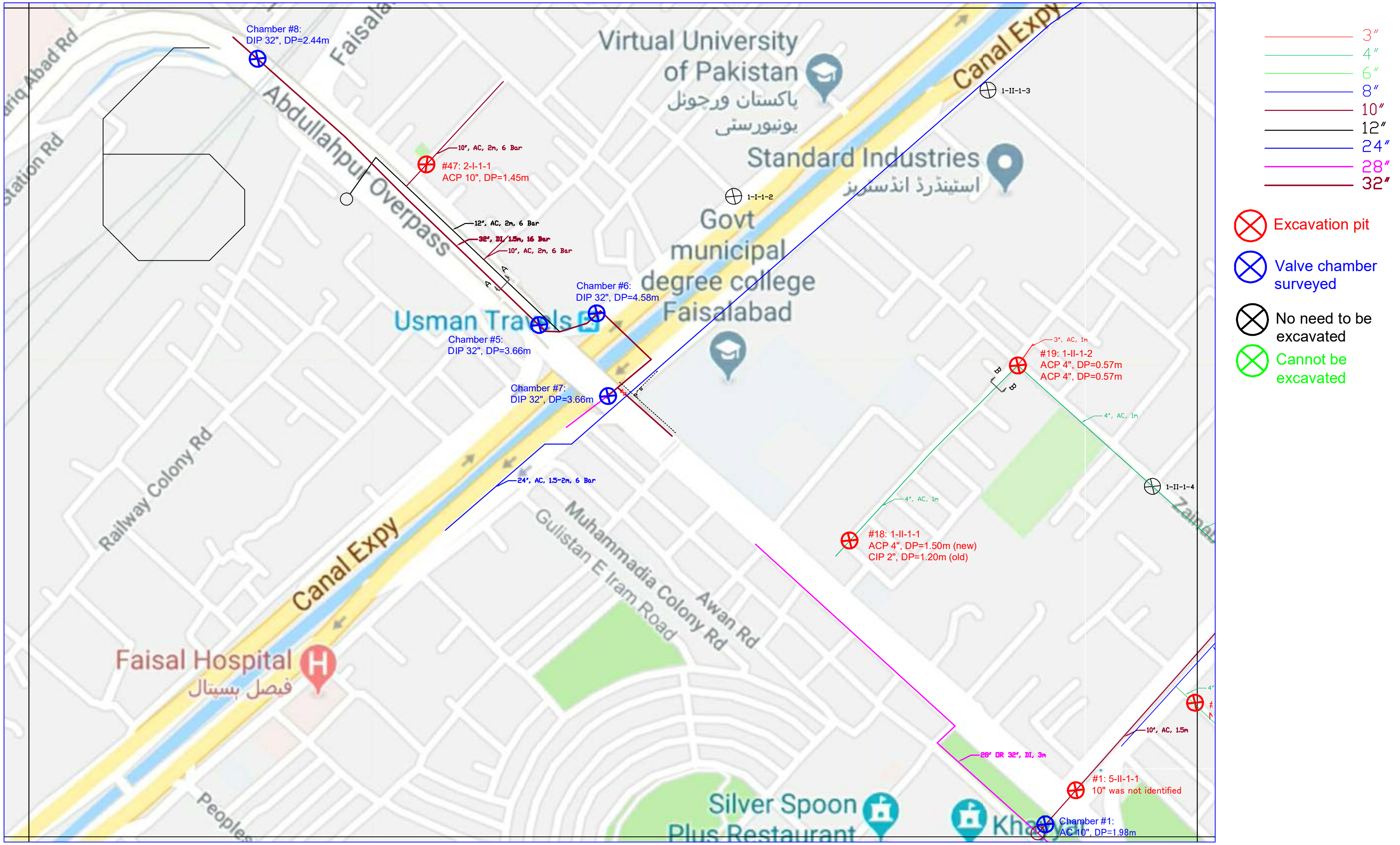
The cross-sectional map is basec on interviews with WASA staff an does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.



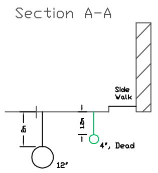


Cross Section

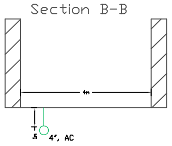
The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.



Section A-A

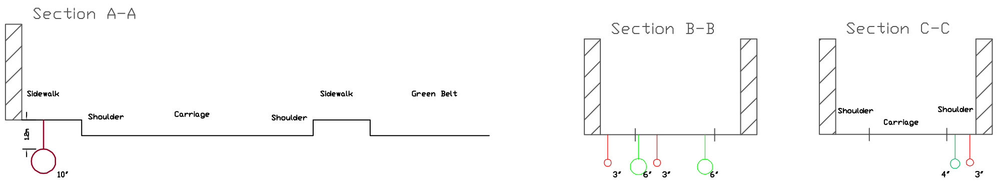


Section B-B



Cross Section

The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.



Cross Section

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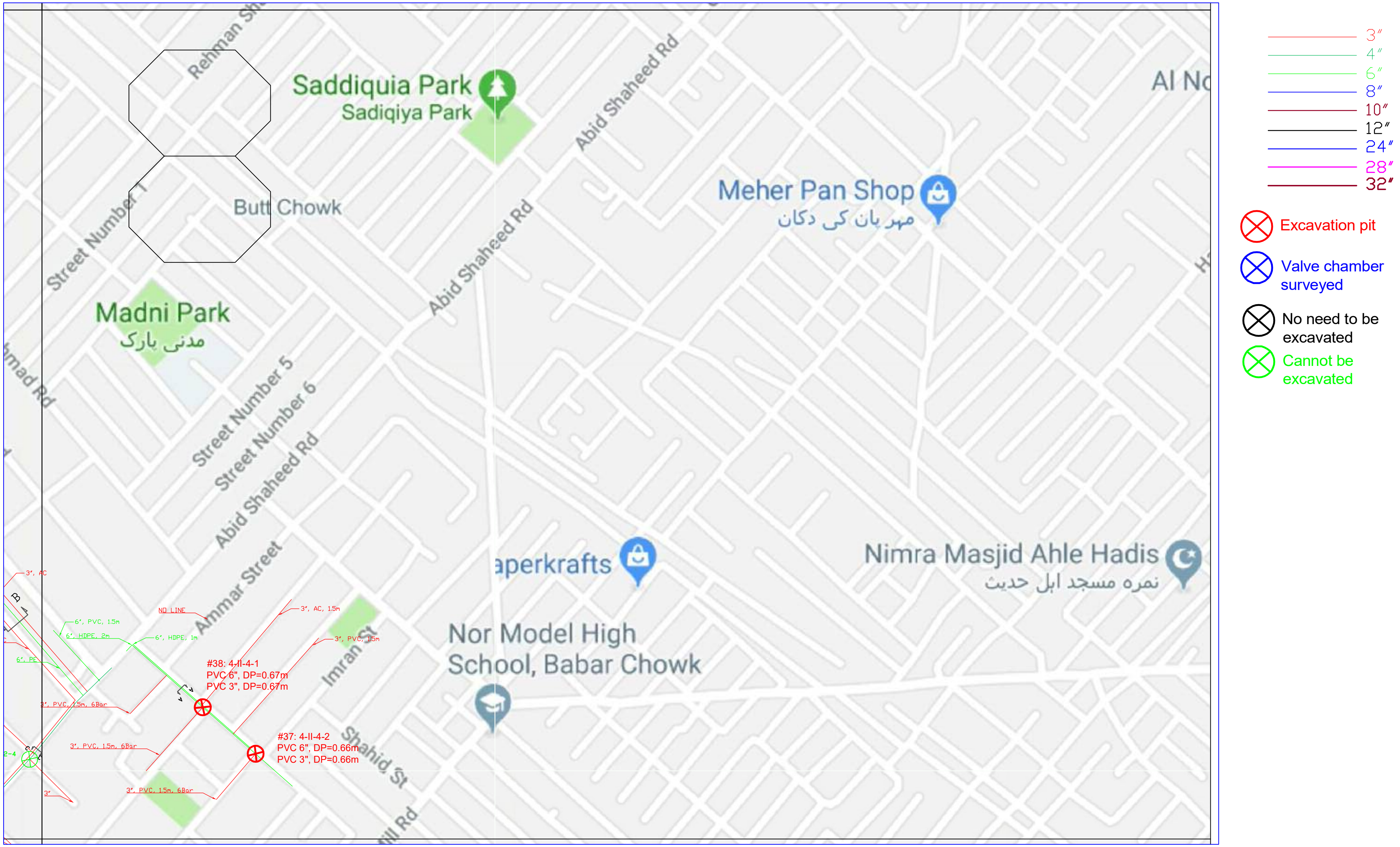
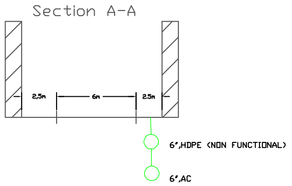
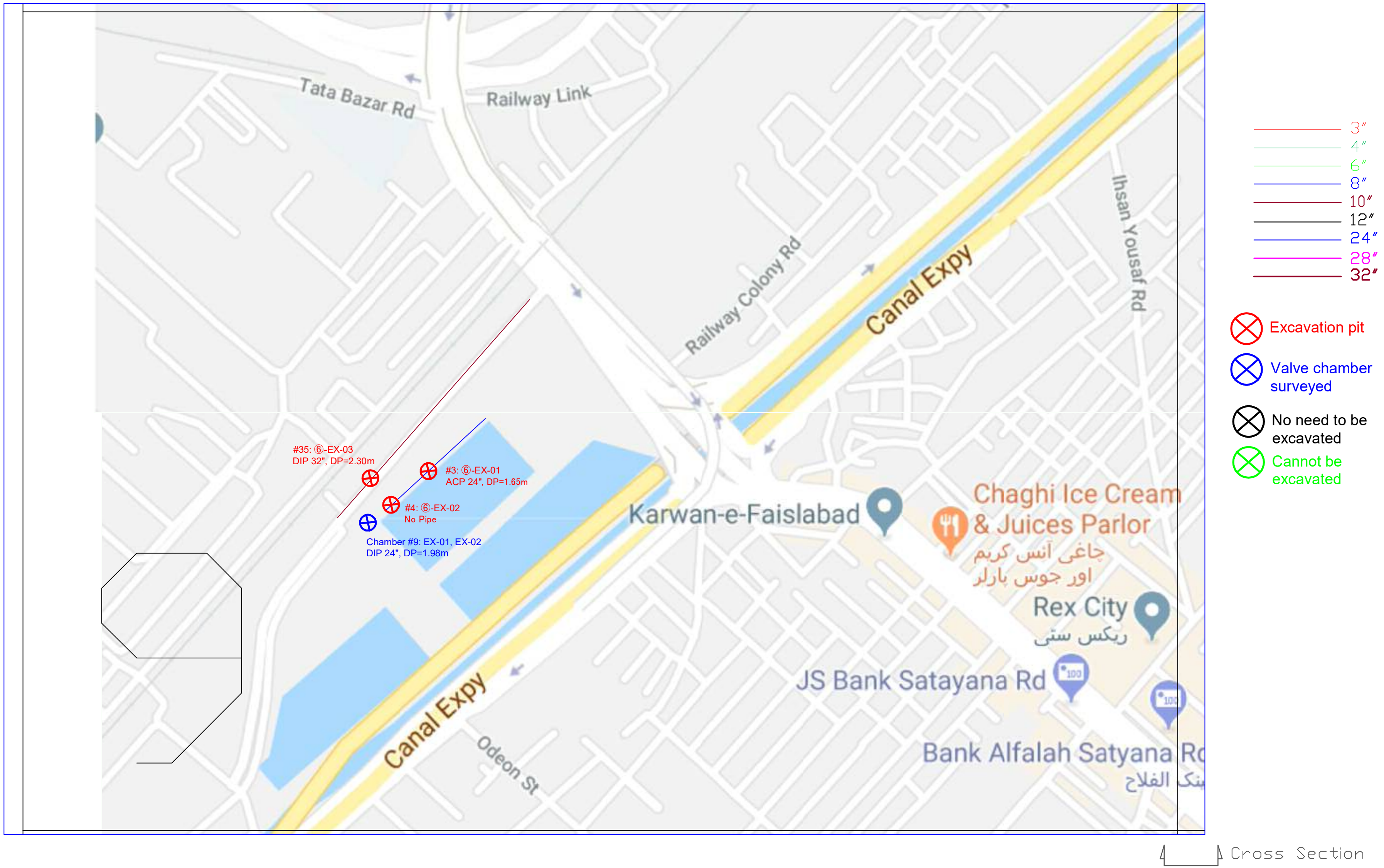
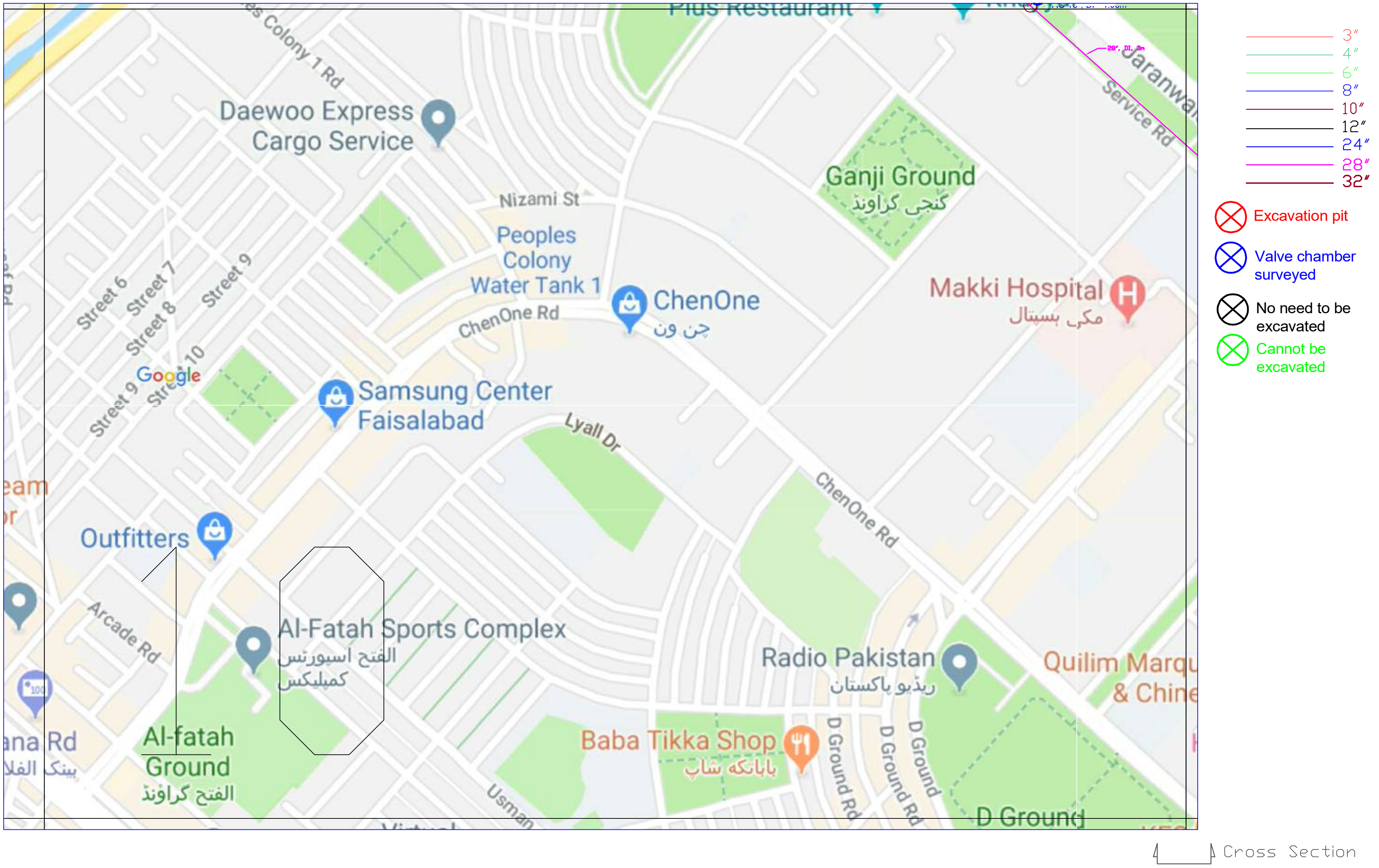




The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.

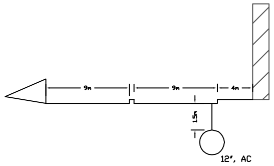


The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.

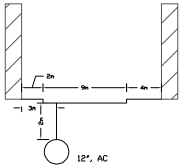


The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.

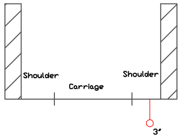
Section A-A



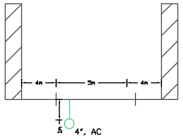
Section B-B



Section C-C

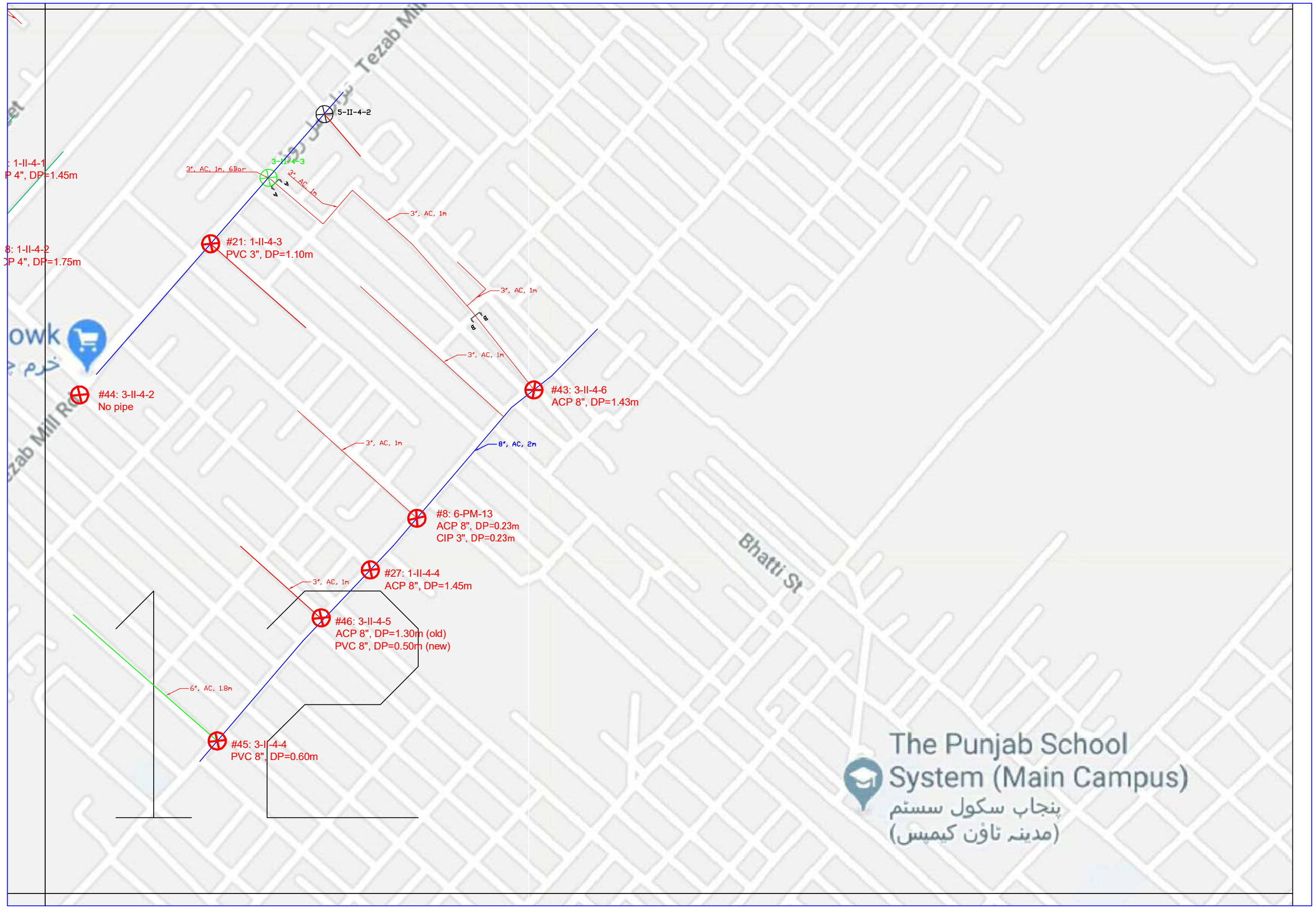


Section D-D



Cross Section

The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.



— 3″
— 4″
— 6″
— 8″
— 10″
— 12″
— 24″
— 28″
— 32″

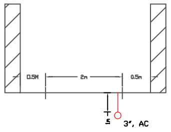
⊗ Excavation pit

⊗ Valve chamber surveyed

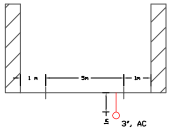
⊗ No need to be excavated

⊗ Cannot be excavated

Section A-A

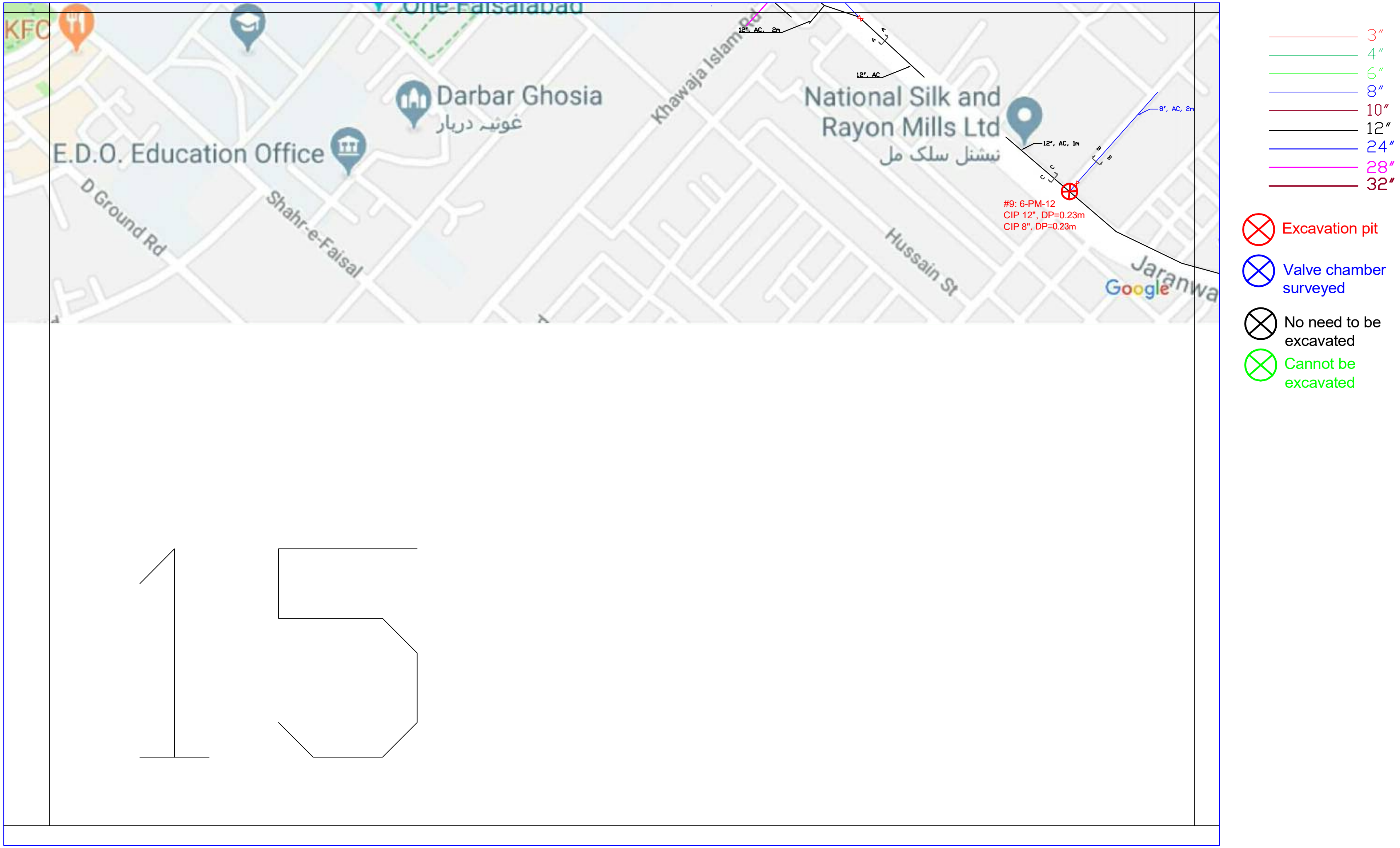


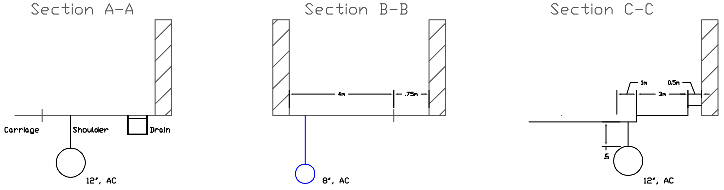
Section B-B



Cross Section

The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.





Cross Section

The cross-sectional map is based on interviews with WASA staff and does not reflect the excavation results. See the report for the locations of the pipes identified in the survey.

# Appendix7 References

## (4) Preliminary Design

# Preliminary Design

Table of Contents Page

# 1. Technical Parameter of Intake and Treatment Facilities

# 1. Technical Parameter of Intake and Treatment Facilities

## 1.1 Intake and Raw Water Transmission Facilities

(1) Planned Intake Capacity

Production capacity is set at 45,500 m3/d (10 mgd).

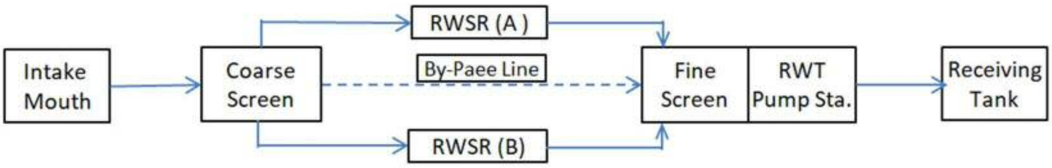
Intake capacity is designed at 5% of production capacity.

Therefore, design capacity of intake becomes 47,900 $m^3$/d (45,500 x 1/(1-5%).

note: Water right from the Irrigation Department is 20 cfs (48,900 $m^3$/d) which exceeds above design capacity of intake.

(2) Flow Diagram of Intake and Raw Water Transmission

Water of the irrigation canal (RBC: Rahk Branch Canal) is transmitted through coarse screen to the existing raw water storage reservoirs (RWSR A and B). Clarified water in RWSR is transmitted to the raw water transmission pump station after screening by fine screen, then it is transferred to the Receiving tank for water purification process. The by-pass line is provided for direct transmission to the raw water transmission pump station during winter season when raw water turbidity becomes low in the irrigation canal. The flow diagram of intake and transmission is shown in flow chart below.



(3) Intake and Raw Water Transmission Facilities

1) Intake Mouth

Water is taken from RBC at its most down stream, where its cross section is about 12m width bottom with no lining and concrete lining at the both sides with slope of 1:1.5. Water depth is measured at a.1.54 m where water level and bottom level is measured as + 184.86 and + 183.32 respectively, thus area of cross section becomes about 22 m2. According to the irrigation canal authority, the design flow there is 11. 27 m3/s and velocity is calculated at 0.51 m/s. Right after the intake point, water is diverted to Dijkot Disty (distribution canal). According to the information by a operator in OJK WTP, water level of the canal is stable within a small change.

Dimensions of Intake Mouth

Main road runs along RBC at the intake point, therefore limited space is available for construction of intake mouth (about 3.3 m between road edge and canal shoulder).

| | | | | |
|---|---|---|---|---|
| Front Yard | front yard level (50 cm higher than canal bed) | | + | 183.82 m |
| Inflow velocity | | | < | 0.6 m/s |
| Cross section | 2 intake mouths are provided | width | | 0.6 m |
| | each having dimensions | water depth | | 1.01 m |
| | | cross section area | | 0.606 $m^2$ |
| | inflow velocity | | | 0.46 m/s < 0.6 |
| Appurtenant Facilities | Stop log at mouth<br>screen is provided in the water treatment plant due to limited space available at the site of intake mouth for operation and maintenance. | | | |

2) Raw Water Transmission Main (Intake mouth ~ Coarse screen)

| | |
|---|---|
| Pipe Materials | Ductile Cast Iron |
| Diameter | 800 mm |
| Velocity | 1.10 m/s |

3) Coarse Screen and Branch Valve Chamber

| | | | |
|---|---|---|---|
| Coarse Screen | Number | | 1 unit |
| | Type | | Manual operation bar screen |
| | width | | 1.6 m |
| | height | | 3.0 m |
| | bar spacing | | 60 mm |
| Branch Valve | Number | to RWSR A & B and By-pass to RWS Pump Sta. | 3 units |
| | Type | | Short body butterfly valve |
| | Diameter | | 800 mm |

4) Inflow and Outflow of RWSR

Inflow

Transmission pipe is installed to prevent short cut flow from inflow to outflow and to utilized capacity and surface area of RWSR effectively.

| | | |
|---|---|---|
| Pipe Materials | | Reinforced concrete pipe |
| Diameter | | 900 mm |

Outflow pit

Provide two weirs placed at the pit for each RWSR for surface water intake, where submerged weir is used

| | | |
|---|---|---|
| Overflow rate | per one weir | 0.277 $m^3/s$ |
| Weir width | | 1.0 m |
| Overflow height | | 0.5 m |

During canal stoppage period, a gate is provide at the bottom of the pit to intake stored canal water in RWSR

| | |
|---|---|
| Number | 1 unit |
| Size | 600 x 600 mm |

Outlet Pipe (RWSR ~ RWT Pump Sta.)

| | |
|---|---|
| Pipe Materials | Ductile Cast Iron |
| Diameter | 800 mm |
| Velocity | 1.10 m/s |

5) Raw Water Transmission Pump Station

Receiving Chamber

Fine screen is provided in channels before pump well of RWT Pump Sta.

The dimensions of channel are

| | |
|---|---|
| Width | 1.15 m |
| Length | 2.9 m |
| Height | 4.3 m |

Install a gate at inflow and outflow of the channel respectively for maintenance of fine screen

| | | |
|---|---|---|
| Number | at each channel | 2 units |
| Size | | 600 x 600 mm |

| | | |
|---|---|---|
| Fine Screen | Type | Automatic vertical mesh screen |
| | Number | 2 units |
| | width | 1 m |
| | height | 5.4 m |
| | mesh | 12 mm |

Pump Well

Dimensions of pump well is determined to fit those pump room (length and height)

| | |
|---|---|
| Width | 3.6 m |
| Length | 19.6 m |
| Water depth | 4.3 m |
| Effective capacity | 303 $m^3$ |
| Detention time | 9 min |

| | | | |
|---|---|---|---|
| Pump Room | Dimensions of pump room is determined based on capacity and number of pumps with appurtenant equipment (flow meter, control valve, etc.) | | |
| | Width | | 4.2 m |
| | Length | | 20.0 m |
| | Height | below beam soffit | 6.6 m |
| Electric Room | Dimensions of electric room is determined to meet the spaces required for electric panels for power, pumps and control together with hatch room, etc. | | |
| | Width | | 4.2 m |
| | Length | | 20.0 m |
| | Height | below beam soffit | 3.5 m |

### (6) Raw Water Transmission Main

Dimensions of a flow meter and a control valve which are installed in the pump room.

| | | |
|---|---|---|
| Flow meter | Type | Electric magnetic flow meter |
| | Diameter | 500 mm |
| Flow control valve | Type | Butterfly valve |
| | Diameter | 500 mm |
| Transmission Main (Raw Water Transmission Pump Sta. ~ Receiving Well) | | |
| | Pipe Materials | Ductile Cast Iron |
| | Diameter | 700 mm |

## 1.2 Water Treatment Plant Facilities

### (1) Pre-Treatment Facilities (Flash Mixing, Flocculation and Sedimentation Tanks)

| | | | |
|---|---|---|---|
| Production Capacity | | | 45,500 $m^3/d$ |
| Treatment Capacity | 処理過程のロス | 5% | 47,900 $m^3/d$ |
| | | | 2,000 $m^3/h$ |
| | | | 33.3 $m^3/min$ |
| | | | 0.554 $m^3/s$ |

1) Receiving Tank

| | | |
|---|---|---|
| Detention time | | 3 min. |
| Number of compartments | | 2 units |
| Dimensions per compartment | Width | 3.0 m |
| | Length | 3.0 m |
| | Water depth | 5.5 m |
| | Capacity (per tank) | 49.5 $m^3$ |

| | | | | | |
|---|---|---|---|---|---|
| Appurtenant | Inlet pipe | Diameter | 700 mm | | 1 no. |
| | Inflow gate | Size | 600 x 600 mm | | 2 units |
| | By-pass gate | Size | 500 x 500 mm | let channel | 1 nuits |
| | Outlet pipe | Diameter | 600 mm | | 2 nos. |
| | Drain pipe | Diameter | 150 mm | | 2 nos. |

2) Flash Mixing Tank

| | | |
|---|---|---|
| Mixing Method | | Hydraulic Mixing (Water Fall) |
| Mixing Intensity | | 500 $sec^{-1}$ |
| Number of Tanks | | 2 tanks |
| Treatment Capacity per Tank | 23,950 $m^3/d$ | 0.277 $m^3/s$ |

| | | at Inflow | at Outflow (Mixing) |
|---|---|---|---|
| Detention Time | | 146 sec | 24 sec |
| Dimensions | Width | 3.0 m | 3.0 m |
| | Length | 3.0 m | 0.8 m |
| | Water depth | 4.5 m | 2.8 m |
| | Capacity | 40.5 $m^3$ | 6.72 $m^3$ |
| Mixing Intensity | Water temperature | | 15 ℃ |
| | Mixing intensity | - | 497 $sec^{-1}$ |

Mixing Intensity

$G = (1/\mu \text{x} (\rho \text{x } g \text{ x } q \text{ x } hf / V)^{0.5} =$ 497 $sec^{-1}$

ここに、

| | | |
|---|---|---|
| $\mu$ : Viscosity | 0.00098 kg/m/s |
| $\rho$ : Specific gravity of water | 1,000 $kg/m^3$ |
| g : Gravity acceleration | 9.8 $m/sec^2$ |
| q : Flow rate | 0.277 $m^3/s$ |
| hf: Head loss (freefall depth) | 0.60 m |
| V : Volume | 6.72 $m^3$ |

3) Flocculation Tank

| | | | |
|---|---|---|---|
| Method | | | Up-and-Down Flow |
| Number of Tanks | | | 4 tanks |
| Treatment Capacity per Tank | | 11,975 $m^3/d$ | 0.139 $m^3/s$ |
| Mixing Intensity | | about | 20 ~ 60 $sec^{-1}$ |
| Number of Channels | | | 4 列 |
| Dimensions per Channel | Width | | 1.85 m |
| | Length | | 9.75 m |
| | Water depth | | 3.5 ~ 3.8 m |
| Detention Time | | about | 30 min |
| Energy of Dissipation (GT-value) | | about | 80,000 |

$G = (1/\mu * (\rho * g * q * hf / V))\text{^}0.5$

| | | | |
|---|---|---|---|
| where, | μ: | viscosity (15℃) | 0.00098 kg/m/s |
| | ρ: | specific gravity of water | 1,000 $kg/m^3$ |
| | g : | gravity acceleration | 9.8 m/s^2 |
| | q : | flow rate | variable $m^3/s$ |
| | V : | volume | variable $m^3$ |

**Energy Dissipation by Phases**

a. Designed Treatment Capacity (Day Maximum Demand in 2038) per Tank 0.1386 $m^3/s$

| | | Channel Number | | | | |
|---|---|---|---|---|---|---|
| Dimensions | unit | No.1 | No.2 | No.3 | No.4 | Total |
| Baffle Wall | nos. | 5 | 5 | 5 | 5 | 20 |
| Baffle Plate | nos. | 3 | 4 | 5 | 6 | 18 |
| slit dia. and layout | mm | $^{w}300$ x $^{h}80$ x $^{n}4$ | | | | |
| area of slit | $m^2$ | 0.288 | 0.384 | 0.480 | 0.576 | - |
| Velocity at Slit | m/s | 0.481 | 0.361 | 0.289 | 0.241 | - |
| Head Loss at Slit | m | 0.164 | 0.092 | 0.059 | 0.041 | 0.356 |
| Volume of Channel | $m^3$ | 68.1 | 65.2 | 63.5 | 62.4 | 259.2 |
| width | m | 1.85 | 1.85 | 1.85 | 1.85 | - |
| length | m | 9.7 | 9.7 | 9.7 | 9.7 | - |
| water depth | m | 3.80 | 3.63 | 3.54 | 3.48 | 3.61 |
| Detention time of Channel | sec | 491 | 470 | 458 | 450 | 1,869 |
| Mixing Intensity | sec-1 | 57.8 | 44.2 | 35.9 | 30.2 | 43.6 |
| GT-value | - | 28,400 | 20,800 | 16,400 | 13,600 | 79,200 |

b. Designed Treatment Capacity (Day Minimum Demand in 2038) per Tank 0.1048 $m^3/s$

| | | Channel Number | | | | |
|---|---|---|---|---|---|---|
| Dimensions | unit | No.1 | No.2 | No.3 | No.4 | Total |
| Baffle Wall | nos. | 5 | 5 | 5 | 5 | 20 |
| Baffle Plate | nos. | 3 | 4 | 5 | 6 | 18 |
| slit dia. and layout | mm | $^{w}300$ x $^{h}80$ x $^{n}4$ | | | | |
| area of slit | $m^2$ | 0.288 | 0.384 | 0.480 | 0.576 | - |
| Velocity at Slit | m/s | 0.364 | 0.273 | 0.218 | 0.182 | - |
| Head Loss at Slit | m | 0.094 | 0.053 | 0.034 | 0.023 | 0.204 |
| Volume of Channel | $m^3$ | 65.5 | 63.8 | 62.9 | 62.3 | 255 |
| width | m | 1.85 | 1.85 | 1.85 | 1.85 | - |
| length | m | 9.7 | 9.7 | 9.7 | 9.7 | - |
| water depth | m | 3.65 | 3.56 | 3.50 | 3.47 | 3.55 |
| Detention time of Channel | sec | 625 | 609 | 600 | 594 | 2,428 |
| Mixing Intensity | sec-1 | 44.6 | 33.9 | 27.4 | 22.6 | 33.3 |
| GT-value | - | 27,900 | 20,600 | 16,400 | 13,400 | 78,300 |

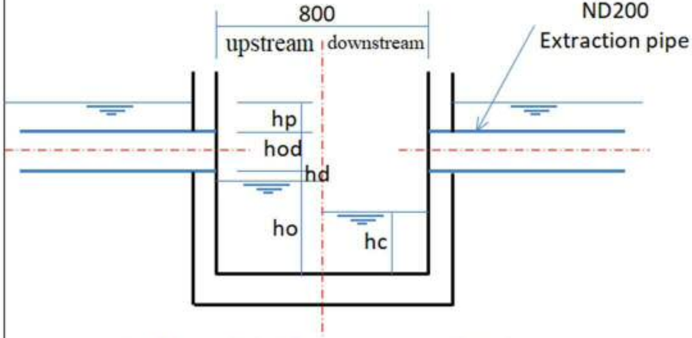
c. Designed Treatment Capacity (Day Minimum Demand in 2023) per Tank 0.0626 m3/s

| | | 水路ナンバー | | | | |
|---|---|---|---|---|---|---|
| Dimensions | unit | No.1 | No.2 | No.3 | No.4 | Total |
| Baffle Wall | nos. | 5 | 5 | 5 | 5 | 20 |
| Baffle Plate | nos. | 3 | 4 | 5 | 6 | 18 |
| slit dia. and layout | mm | $^{w}300$ x $^{h}75$ x $^{n}4$ | | | | |
| area of slit | $m^2$ | 0.317 | 0.384 | 0.480 | 0.576 | - |
| Velocity at Slit | m/s | 0.198 | 0.163 | 0.130 | 0.109 | - |
| Head Loss at Slit | m | 0.028 | 0.019 | 0.012 | 0.008 | 0.067 |
| Volume of Channel | $m^3$ | 63.0 | 62.5 | 62.1 | 61.9 | 250 |
| width | m | 1.85 | 1.85 | 1.85 | 1.85 | - |
| length | m | 9.7 | 9.7 | 9.7 | 9.7 | - |
| water depth | m | 3.51 | 3.48 | 3.46 | 3.45 | |
| Detention time of Channel | sec | 1,007 | 999 | 992 | 989 | 3,987 |
| Mixing Intensity | sec-1 | 24.8 | 20.5 | 16.4 | 13.4 | 19.3 |
| GT-value | - | 25,000 | 20,500 | 16,300 | 13,300 | 75,100 |

### 4) Sedimentation Tank

| | | | | |
|---|---|---|---|---|
| Metod | | | | Inclining Tube |
| Number of Tank | | | | 4 tanks |
| Treatment Capacity per Tank | | | 12,000 $m^3$/d | 500 $m^3$/h |
| Surface Loading | | | | 1 $m^3$/h/$m^2$ |
| Efficiency | | | | 80 % |
| Inclining Tube | Size of tube | | | 80 x 80 mm |
| | Installation height | | | 1.0 m |
| | Installation angle to horizontal | | | 60 deg. |
| | Effective area | | | 0.577 $m^2$/m |
| | Module of inclining tube （1.0 x 1.0m） | | | 7.22 $m^2$/module |
| | Effective area of tank | | | 625 $m^2$/tank |
| | Number of modules | | | >87 units/tank |
| Dimension of Tank | Width | Number of compartments | | 2 compartments |
| | | Number of modules per compartment | | 4 units |
| | | Distance between module and side wall | about | 10 cm |
| | | Width of clarified water collecting channel (incl.side wall) | | 1.3 m |
| | | Width per tank | | 9.7 m |
| | Length | Number of modules （87 x 1/8） | | 11 units |
| | | Installation length of modules (incl. space between modules) | | 12.0 m |
| | | Stilling zone length (incl. wall) （1.5 + 0.25） | | 1.75 m |
| | | Length of tank | | 13.75 m |
| | Water depth | Water depth above inclining tube | | 0.8 m |
| | | Installation height of inclining tube（incl. support） | | 1.2 m |
| | | Height under the inclining tube | | 1.5 m |
| | | Free board | | 0.4 m |
| | | Total water depth | | 3.5 m |
| Clarified Water Extraction | Method | | | Pipes |
| | | Extraction pipe | Diameter | 200 mm |
| | | Number of pipes | | 4 nos./compartment |
| | | Weir loading | | < 200 $m^3$/d/m |
| | Clarified water extraction channel | | | Reinforced concrete |
| | | Net width | | 0.8 m |

## Clarified Water Extraction Hydraulics



hp: head loss of pipe
hdo: outer diameter of pipe
hd: freefall depth
ho: upstream water depth of channel
hc: critical depth at outlet of channel
h: head loss of clarified water extraction
h = hp + hdo + hd + ho - hc

### Head loss of clarified water extraction pipe

| | | |
|---|---|---|
| Clarified water flow per tank | | 0.139 $m^3$/s |
| Extraction pipe | nominal diameter | 200 mm |
| | outer diameter | 216 mm |
| | number of slit pipes | 8 nos. |
| | velocity | 0.98 m/s |
| | number of slit per pipe | 10 nos/pipe |
| | total number of slit | 80 nos/tank |
| | diameter of slit | 65 mm |
| | area of slit | 0.265 $m^2$ |
| | velocity at slit | 0.522 m/s |
| | head loss of slit | 0.039 m |
| | outer diameter of slip hdo: | 0.216 m |
| | freedrop at slit pipe outlet | 0.051 m |
| | head loss of slit pipe<br>（hor+hod+hd) | 0.306 m |

### Head loss of clarified water extraction channel

| | | |
|---|---|---|
| Critical water depth | $hc = (\alpha x q^2 /(g x b^2))^{1/3} =$ | 0.150 m |
| | where、 α : coefficien | 1.1 |
| | g : gravity accelerati | 9.8 |
| | b : width of channel | 0.8 |
| Water depth at the most upstream | | |
| | ho = 1.732 x hc = | 0.260 m |
| Head loss of clarified water extraction channel | | 0.110 m |

## (2) Rapid Sand Filter and Clear Water Reservoir/Transmission Pump Station)

### 1) Rapid Sand Filter

a. Treatment Capacity

| | | | |
|---|---|---|---|
| Production | | | 45,500 $m^3$/d |
| Treatment capacity | loss | 3 % | 46,900 $m^3$/d |

b. Dimensions

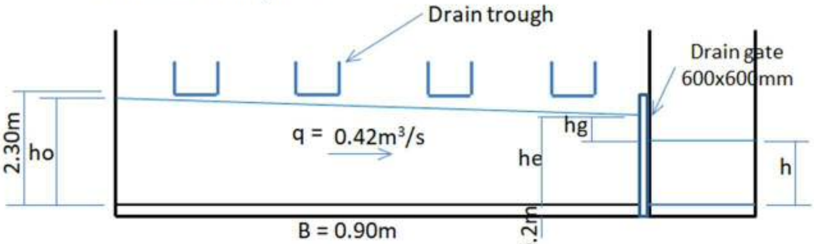
| | | | | |
|---|---|---|---|---|
| Type | Filter media | | | Sand (single layer) |
| | Filtration | | | Constant rate |
| | Flow control | | | Equal split at inlet |
| Filtration Rate | | | | 140 m/d |
| Filter Media | Filter sand | Effective size | | 0.9 mm |
| | | Uniformity coefficient | | 1.4 |
| | | Thickness of sand layer | | 100 cm |
| | Supporting gravel | Number of layers | | 4 layers |
| | | Thickness of each layer | | 5 cm |
| | | Range of particle size | | 2 ~ 50 mm |
| | | Thickness of gravel layer | | 20 cm |
| Underdrain | Type | | | nozzle type |
| | Head loss at backwashing | | Maximum | 70 cm |
| Number of Filters | | | | 8 filters |
| | Filtration flow per filter | | | 5,860 $m^3$/d |
| Dimensions of Filter | Width | | | 4.5 m |
| | Length | | | 9.4 m |
| | Filter area | | | 42.3 $m^2$ |
| | | Filtration rate | | 139 m/d |
| | Height | | | 5.75 m |
| | | Water depth above sand | | 1.25 m |
| | | Clogging loss | | 1.30 m |
| | | Thickness of Filter sand and gravel | | 1.2 m |
| | | Underdrain | | 1.1 m |
| | | Free board | | 0.9 m |
| | Backwash drain gutter | Width | | 0.9 m |
| | | Length | | 9.4 m |
| | | Water depth | | 4.5 m |
| | Operation/ Pipe gallery | Width | | 4 m |
| | | Length | | 44.4 m |

|  |  |  |  |
|---|---|---|---|
| Filter Washing | Method |  | Air + Backwash |
|  | Air Scouring | Scouring rate | 0.9 ~ 1.0 m/min |
|  |  | Scouring time | 10 min |
|  | Backwash | Rate of initial backwash（Air+Water） | 0.25 m/min |
|  |  | Washing time | 2 ~ 3 min |
|  |  | Backwasing （water only） | 8 ~ 10 min |
|  | Backwash water drain trough | Number o1（1 池当たり） | 4 本 |
|  |  | Width | 40 cm |
|  |  | Height | 40 cm |
|  |  | Length | 4.65 m |

Hydraulics of Backwash Water Drain Trough and Gutter

|  |  |  |
|---|---|---|
| Filter bed area |  | 42.3 $m^2$ |
| Backwash rate |  | 0.5 m/min |
| Backwash flow |  | 21.2 $m^3$/min |
|  |  | 0.353 $m^3$/s |
|  | allowance | 20 % |
|  | Design backwash flow | 0.42 $m^3$/s |
| Wash water train trou | Number of trough | 4 nos. |
|  | Spacing between troughs | 2.35 m |
|  | Drain flow per trough | 0.105 $m^3$/s |
|  | Critical water depth | 0.198 m |
|  | Most upstream water depth | 0.343 m |

Wash water drain gutter



$he^3 - ho^2 x\ he + 2\ x\ hc$ より he = 2.200

where, hc : critical water depth ($\alpha$ x $Q^2/gB^2$) 0.280 m

he : outflow water depth **2.200** m

ho : upstream water depth 2.205 m

hg : head loss of drain gate 0.193 m

h : water depth of drain channel (assumption) 2.008 m

Pipe, Valves and Gates of Filte

| pipe･valve･gate | size (mm) | velocity (m/s) | pipe･valve･gate | size (mm) | velocity (m/s) |
|---|---|---|---|---|---|
| Inlet gate | 300 x 300 | 0.76 | Backwash main | 500 | 2.01 |
| Wash drain gate | 600 x 600 | 1.10 | Air pipe | 250 | 15.3 |
| Filtered water pipe | 250 | 1.51 | Air main | 300 | 7.8 |
| Filtered water main | 800 | 1.08 | Filter drain pipe | 150 | - |
| Backwash pipe | 450 | 2.48 | Filter drain main | 200 | - |

## 2) Clear Water Reservoir and Treated Water Transmission Pump Station

### a. Clear Water Reservoir

| | | | |
|---|---|---|---|
| Detention Time* | | apprx. | 1.2 h |
| Capacity | | | 2,280 $m^3$ |
| Number of Compartment | | | 2 nos. |
| Dimensions per Compartment | Width | | 15.8 m |
| | Length | | 17.2 m |
| | Effective water depth | | 4.5 m |
| | Total volume | | 1,223 m |
| | Effective volume | (approx. 98%) | 2,400 m3 |
| | Free board | | 0.65 m |
| | Detention time | | 1.27 hours |

注* refer to Attached Table 1-1 volume of Clear Water Reservoir at Canal Stoppage

### b. Treated Water Transmission Pump Station

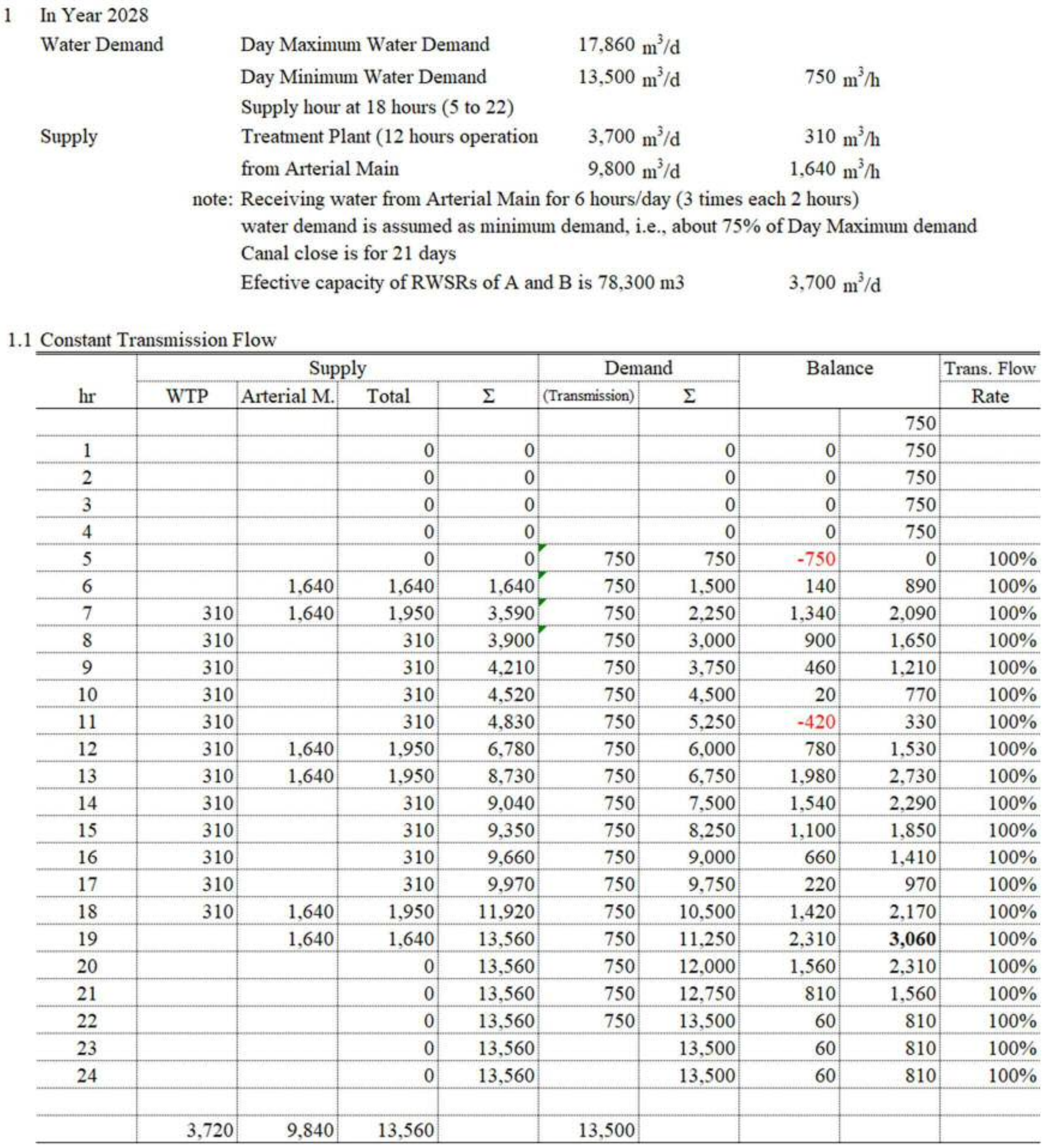
**Pump Room** Dimensions of pump room is determined based on capacity and number of pumps with appurtenant equipment (flow meter, control valve, etc.)

| | | |
|---|---|---|
| Width | including pipe gallery of pump suction and delivery pipes | 9.4 m |
| Length | | 32.4 m |
| Height | below beam soffit | 7.8 m |

**Electric Room** Dimensions of electric room is determined to meet the spaces required for electric panels of power, pumps and controlポtogether with hatch room, etc.

| | | |
|---|---|---|
| Width | | 4.2 m |
| Length | | 32.4 m |
| Height | below beam soffit | 3.5 m |

## Attached Table 1 – 1 Volume of Clear Water Reservoir at Canal Stoppage



1 In Year 2028

| | | | |
|---|---|---|---|
| Water Demand | Day Maximum Water Demand | 17,860 $m^3/d$ | |
| | Day Minimum Water Demand | 13,500 $m^3/d$ | 750 $m^3/h$ |
| | Supply hour at 18 hours (5 to 22) | | |
| Supply | Treatment Plant (12 hours operation | 3,700 $m^3/d$ | 310 $m^3/h$ |
| | from Arterial Main | 9,800 $m^3/d$ | 1,640 $m^3/h$ |

note: Receiving water from Arterial Main for 6 hours/day (3 times each 2 hours)
water demand is assumed as minimum demand, i.e., about 75% of Day Maximum demand
Canal close is for 21 days
Efective capacity of RWSRs of A and B is 78,300 m3 3,700 $m^3/d$

1.1 Constant Transmission Flow

| | Supply | | | | Demand | | Balance | | Trans. Flow |
|---|---|---|---|---|---|---|---|---|---|
| hr | WTP | Arterial M. | Total | Σ | (Transmission) | Σ | | | Rate |
| | | | | | | | | 750 | |
| 1 | | | 0 | 0 | | 0 | 0 | 750 | |
| 2 | | | 0 | 0 | | 0 | 0 | 750 | |
| 3 | | | 0 | 0 | | 0 | 0 | 750 | |
| 4 | | | 0 | 0 | | 0 | 0 | 750 | |
| 5 | | | 0 | 0 | 750 | 750 | -750 | 0 | 100% |
| 6 | | 1,640 | 1,640 | 1,640 | 750 | 1,500 | 140 | 890 | 100% |
| 7 | 310 | 1,640 | 1,950 | 3,590 | 750 | 2,250 | 1,340 | 2,090 | 100% |
| 8 | 310 | | 310 | 3,900 | 750 | 3,000 | 900 | 1,650 | 100% |
| 9 | 310 | | 310 | 4,210 | 750 | 3,750 | 460 | 1,210 | 100% |
| 10 | 310 | | 310 | 4,520 | 750 | 4,500 | 20 | 770 | 100% |
| 11 | 310 | | 310 | 4,830 | 750 | 5,250 | -420 | 330 | 100% |
| 12 | 310 | 1,640 | 1,950 | 6,780 | 750 | 6,000 | 780 | 1,530 | 100% |
| 13 | 310 | 1,640 | 1,950 | 8,730 | 750 | 6,750 | 1,980 | 2,730 | 100% |
| 14 | 310 | | 310 | 9,040 | 750 | 7,500 | 1,540 | 2,290 | 100% |
| 15 | 310 | | 310 | 9,350 | 750 | 8,250 | 1,100 | 1,850 | 100% |
| 16 | 310 | | 310 | 9,660 | 750 | 9,000 | 660 | 1,410 | 100% |
| 17 | 310 | | 310 | 9,970 | 750 | 9,750 | 220 | 970 | 100% |
| 18 | 310 | 1,640 | 1,950 | 11,920 | 750 | 10,500 | 1,420 | 2,170 | 100% |
| 19 | | 1,640 | 1,640 | 13,560 | 750 | 11,250 | 2,310 | **3,060** | 100% |
| 20 | | | 0 | 13,560 | 750 | 12,000 | 1,560 | 2,310 | 100% |
| 21 | | | 0 | 13,560 | 750 | 12,750 | 810 | 1,560 | 100% |
| 22 | | | 0 | 13,560 | 750 | 13,500 | 60 | 810 | 100% |
| 23 | | | 0 | 13,560 | | 13,500 | 60 | 810 | 100% |
| 24 | | | 0 | 13,560 | | 13,500 | 60 | 810 | 100% |
| | | | | | | | | | |
| | 3,720 | 9,840 | 13,560 | | 13,500 | | | | |

1.2 Water Level Control (Transmission Flow Control)

|  | Supply |  |  |  | Demand |  | Balance |  | Trans. Flow |
|---|---|---|---|---|---|---|---|---|---|
| hr | WTP | Arterial M. | Total | Σ | (Transmission) | Σ |  |  | Rate |
|  |  |  |  |  |  |  |  | 600 |  |
| 1 |  |  | 0 | 0 | 0 | 0 | 0 | 600 |  |
| 2 |  |  | 0 | 0 | 0 | 0 | 0 | 600 |  |
| 3 |  |  | 0 | 0 | 0 | 0 | 0 | 600 |  |
| 4 |  |  | 0 | 0 | 0 | 0 | 0 | 600 |  |
| 5 |  |  | 0 | 0 | 600 | 600 | -600 | 0 | 80% |
| 6 |  | 1,640 | 1,640 | 1,640 | 900 | 1,500 | 140 | 740 | 120% |
| 7 | 310 | 1,640 | 1,950 | 3,590 | 975 | 2,475 | 1,115 | 1,715 | 130% |
| 8 | 310 |  | 310 | 3,900 | 900 | 3,375 | 525 | 1,125 | 120% |
| 9 | 310 |  | 310 | 4,210 | 750 | 4,125 | 85 | 685 | 100% |
| 10 | 310 |  | 310 | 4,520 | 600 | 4,725 | -205 | 395 | 80% |
| 11 | 310 |  | 310 | 4,830 | 600 | 5,325 | -495 | 105 | 80% |
| 12 | 310 | 1,640 | 1,950 | 6,780 | 900 | 6,225 | 555 | 1,155 | 120% |
| 13 | 310 | 1,640 | 1,950 | 8,730 | 975 | 7,200 | 1,530 | 2,130 | 130% |
| 14 | 310 |  | 310 | 9,040 | 900 | 8,100 | 940 | 1,540 | 120% |
| 15 | 310 |  | 310 | 9,350 | 750 | 8,850 | 500 | 1,100 | 100% |
| 16 | 310 |  | 310 | 9,660 | 600 | 9,450 | 210 | 810 | 80% |
| 17 | 310 |  | 310 | 9,970 | 600 | 10,050 | -80 | 520 | 80% |
| 18 | 310 | 1,640 | 1,950 | 11,920 | 750 | 10,800 | 1,120 | 1,720 | 100% |
| 19 |  | 1,640 | 1,640 | 13,560 | 900 | 11,700 | 1,860 | **2,460** | 120% |
| 20 |  |  | 0 | 13,560 | 600 | 12,300 | 1,260 | 1,860 | 80% |
| 21 |  |  | 0 | 13,560 | 600 | 12,900 | 660 | 1,260 | 80% |
| 22 |  |  | 0 | 13,560 | 600 | 13,500 | 60 | 660 | 80% |
| 23 |  |  | 0 | 13,560 | 0 | 13,500 | 60 | 660 |  |
| 24 |  |  | 0 | 13,560 | 0 | 13,500 | 60 | 660 |  |
|  |  |  |  |  |  |  |  |  |  |
|  | 3720 | 9,840 | 13,560 |  | 13,500 |  |  |  | 1.00 |

1.3 Volume of Reservoir:

| | |
|---|---|
| Constrant transmission flow as 844 $m^3/h$ | 3,060 $m^3$ |
| Under transmission flow control | 2,460 $m^3$ |

Dimensions of Reservoir

|  | Constant Transmission Flow | Water Level Control |
|---|---|---|
| width (m) | 31.6 (15.8m x 2 - 0.4) | 31.6 (15.8m x 2 - 0.4) |
| length (m) | 21.6 (4.4m x 5span - 0.4) | 17.2 (4.4m x 4span - 0.4) |
| water depth (m) | 4.5 | 4.5 |
| Effective Area (m2) | 683 (wall thick: 0.4m) | 544 (wall thick: 0.4m) |
| volume (m3) | 3,072 | 2,446 |

## (3) Waste Water Treatment Facilities

Waste water treatment facilities are composed of /Sludge Buffer Tank/Waste Water Tank, Sludge Thickener and Sludge Drying Bed

### 1) Sludge Buffer Tank

a. Sludge Extraction of Sedimentation Tank

| | | | |
|---|---|---|---|
| Treatment Flow | | | 47,900 $m^3/d$ |
| | | | Maximum Turbidity |
| Sludge | Sludge extraction | (times of extraction) | 4 times/d |
| | Maximum Turbidity | (RWST outflow) | 200 NTU |
| | Clarified Water Turbidity | | 5 mg/l |
| | Alum Dosage rate (Solid 17%) | | 33 mg/l |
| | TS/Turbidity | | 1.0 |
| | Sludge | Solid weight | 9,710 kg/d |
| | | Sludge content | 1.0% |
| | | Sludge flow | 970 $m^3/d$ |
| | | Allowance | 20% |
| | | | 1,160 $m^3/d$ |
| | | Sludge flow per extraction | 290 $m^3$/time |

Two tanks of Sludge buffer tank is planned including one stand-by, each having volume of 250 $m^3$ (refer to Attached Table 1-3a Volume of Sludge Buffer Tank)

b. Dimensions of Sludge Holding Tank

| | | |
|---|---|---|
| Number of Tank | | 2 tanks |
| Capacity (at Maximum turbidity,200 NTU) | | 250 $m^3$ |
| Time for Sludge Transfer to Sludge Thickener | | Continuous pump operation under water level control |
| Dimensions | Width | 4.2 m |
| | Length | 20.0 m |
| | Effective water depth | 3.0 m |
| | Volume | 504 $m^3$ |

c. Appurtenant Equipment

Mixer

Submersible mixers to prevent settlement of sludge in tank and transfer sludge with uniform sludge content as possible to sludge thickener. Two mixers per compartment is installed.

Sludge transfer pump

Sludge is transferred by submersible waste water pumps. Two units of pumps including one stand-by are installed in each tank.

Sludge is pumped to a chamber located on top slab of sludge holding tank, from where sludge is transferred to sludge thickener by gravity.

From the said sludge chamber, half of sludge is transferred to sludge thickener and remaining sludge is transferred directly to sludge drying bed by gravity to avoid large scale of sludge thickener when raw water turbidity becomes high.

High turbid raw water of 1,000 NTU or larger will occur only several times in wet sean in a year.

## 2) Waste Water Tank

### a. Backwash Waste Water and Supernatant Water

| | | |
|---|---|---|
| Treatment Flow of Filter | | 46,900 $m^3$/d |
| Number of Filter | | 8 filters |
| Filter Backwash Waste Water | | |
| Filter bed area | | 42.3 $m^2$ |

| Washing | rate ($m^3$/min) | time(min) | waste water |
|---|---|---|---|
| initial | 0.25 | 2 ~ 3 | 21 |
| Final | 0.5 | 8 ~ 10 | 169 |

| | | |
|---|---|---|
| Filter run | | 48 h |
| Washing time per day | | 4 times/d |
| Waste water volume | | 190 $m^3$/time |
| | Allowance | 20% |
| | | 910 $m^3$/d |
| | Inflow of Backwash waste water per time | 230 $m^3$/time |
| Sllid weight | Inflow and outflow turbidity is 5 and 1 respectively | 190 kg/d |
| Solid content | | 0.21% |

| | |
|---|---|
| Supernatant (24 hours continuous inflow) | |
| from Sludge Thickener | 850 $m^3$/d |
| from Sludge Drying Bed | 300 $m^3$/d |

Number of waste water tank is two tanks including one stand-by, each having volume of 210 $m^3$ (refer to Attached Table 1-3b Volume of Waste Water Tank)

### b. Dimensions of Waste Water Tank

| | | |
|---|---|---|
| Number of Tank | | 2 tanks |
| Volume per tank | | 210 $m^3$ |
| Time for Dewateringr | | Continuous pump operation under water level control |
| Dimensions | Width | 4.2 m |
| | Length | 20.0 m |
| | Effective water depth | 2.5 m |
| | Volume | 210 m3 |

### c. Appurtenant Equipment

Mixer Submersible mixers to prevent settlement sludge in waste water in tank and transfer waste water with uniform sludge content as possible to receiving tank for recycle use. Two mixers per tank is installed.

Waste water transfer pump

Two submersible waste water pumps including one stand-by are installed in each compartment.

Pumps for Preventing Overflow

Because no appropriate waste water drain facilities is available around the water treatment plant, all waste water and overflows of plant inflow to the waste water tank.
Therefore, drain pumps are planned to be installed in the waste water tank to drain the RWSR in ordinal plant operation. As required, drain water is pumped to drain channel (former irrigation distribution canal which is not utilized at the present) located along north-west boundary wall of the plant.

### 4) Sludge Thickener

| | | | | |
|---|---|---|---|---|
| Type | | | | Gravity Center Feed Thickener |
| Sludge (solid weight) | | | | 10,080 kg |
| Sludge Loading | | | | 20 kg/d/m$^2$ |
| Number of Thickener | | | | 2 池 |
| Surface Area required | | | | 504 m$^2$ |
| | | | | 252 m$^2$/thickener |
| Dimensions | Diameter | | | 12.8 m |
| | Effective water depth | | | 3.5 m |
| | Sludge | Depth | | 0.5 m |
| | Deposit | Sludge volume) | | 64 m$^3$ |
| | Slope of basin | | | 10% |
| | Size of center feed chamber | | Dia. | 2.5 m |
| | Size Sludge extraction pit | | Dia. | 2.2 m |
| Sludge Extraction | Type of scraper | | | Rotating type |
| | Extraction pipe | | Dia. | 150 mm |

### 5) Thickened Sludge Transfer Pump Station

| | | | | |
|---|---|---|---|---|
| Pump Room | Basement Floor | | | 60 m$^2$ |
| | | Width | | 5 m |
| | | Length | | 12 m |
| | | Height | | 5.55 m |
| Electric Room | Ground Floor | | | 60 m2 |
| | | Width | | 5 m |
| | | Length | | 12 m |
| | | Height | below beam soffit | 3.5 m |

### 6) Sludeg Drying Bed

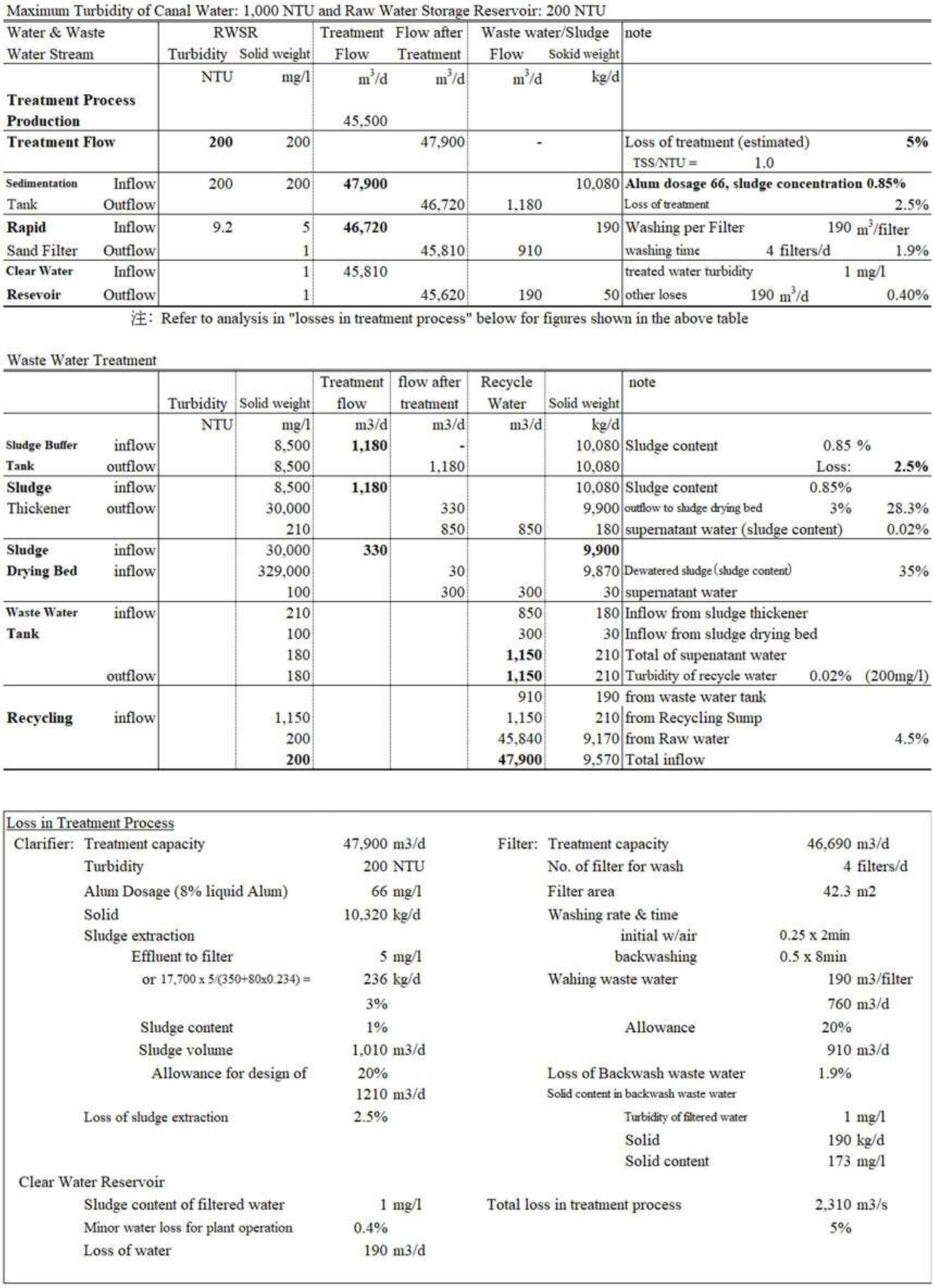
| | | | | |
|---|---|---|---|---|
| Sludge (Solid Weight)$^{*1}$ | | | | 911,400 kg/年 |
| Annual Sludge Loading | | | | 220 kg/m$^2$ |
| Floor Area of Sludge Drying Bed | | | | 4,140 m$^2$ |
| Number of Beds | | | | 7 beds |
| Area | | | | 600 m$^2$/bed |
| Dimensions | Width | | | 20 m |
| | Length | | | 30 m |
| | Filter | Sand | | 30 cm |
| | | Gravel | | 20 cm |
| | Water depth above sand | | | 1.5 m |
| | Free board | | | 50 cm |
| Appurtenant Faculities and Equipment | Piping | Inlet Pipe | PE | 150 mm |
| | | Supernatant Drain | RCP | 150 mm |
| | Stop log | （at supernatant drain pit) | W x H（20cm x 8nos） | 0.6 x 1.6 m |
| | Ramp | （for dried sludge disposal) | W x L (3.0 x 7.5m) | 1 pl/bed |

Note $^{*1}$: Sludge (Solid Weight)

Q = 47,900 $m^3/d$

| Month | Turbidity | Alum | Sludge | | | Sludge by Seasons | | |
|---|---|---|---|---|---|---|---|---|
| | (average) | | kg/d | kg/mon | | Dry Season | Wet Season | Annual (kg) |
| Jan | 21 | 29 | 1,091 | 33,800 | | 33,800 | | |
| Feb | 16 | 27 | 830 | 23,200 | | 23,200 | | |
| Mar | 32 | 34 | 1,674 | 51,900 | | 51,900 | | |
| Apr | 46 | 42 | 2,435 | 73,100 | | | 73,100 | |
| May | 44 | 41 | 2,328 | 72,200 | | | 72,200 | |
| Jun | 67 | 50 | 3,530 | 105,900 | | | 105,900 | |
| Jul | 121 | 59 | 6,218 | 192,800 | | | 192,800 | |
| Aug | 114 | 58 | 5,871 | 182,000 | | | 182,000 | |
| Sep | 52 | 44 | 2,744 | 82,300 | | | 82,300 | |
| Oct | 22 | 30 | 1,151 | 35,700 | | 35,700 | | |
| Nov | 19 | 28 | 984 | 29,500 | | 29,500 | | |
| Dec | 18 | 28 | 937 | 29,000 | | 29,000 | | |
| Ave/Total | 48 | 39 | 2,483 | 911,400 | kg/year | 203,100 | 708,300 | 911,400 |

## Attached Table 1-2 Mass Balance



Maximum Turbidity of Canal Water: 1,000 NTU and Raw Water Storage Reservoir: 200 NTU

| Water & Waste Water Stream | | RWSR Turbidity | RWSR Solid weight | Treatment Flow | Flow after Treatment | Waste water/Sludge Flow | Waste water/Sludge Sokid weight | note |
|---|---|---|---|---|---|---|---|---|
| | | NTU | mg/l | $m^3$/d | $m^3$/d | $m^3$/d | kg/d | |
| **Treatment Process Production** | | | | 45,500 | | | | |
| **Treatment Flow** | | **200** | 200 | | 47,900 | - | | Loss of treatment (estimated) **5%** |
| | | | | | | | | TSS/NTU = 1.0 |
| **Sedimentation** | Inflow | 200 | 200 | **47,900** | | | 10,080 | **Alum dosage 66, sludge concentration 0.85%** |
| Tank | Outflow | | | | 46,720 | 1,180 | | Loss of treatment 2.5% |
| **Rapid** | Inflow | 9.2 | 5 | **46,720** | | | 190 | Washing per Filter 190 $m^3$/filter |
| Sand Filter | Outflow | | 1 | | 45,810 | 910 | | washing time 4 filters/d 1.9% |
| **Clear Water** | Inflow | | 1 | 45,810 | | | | treated water turbidity 1 mg/l |
| **Resevoir** | Outflow | | 1 | | 45,620 | 190 | 50 | other loses 190 $m^3$/d 0.40% |

注：Refer to analysis in "losses in treatment process" below for figures shown in the above table

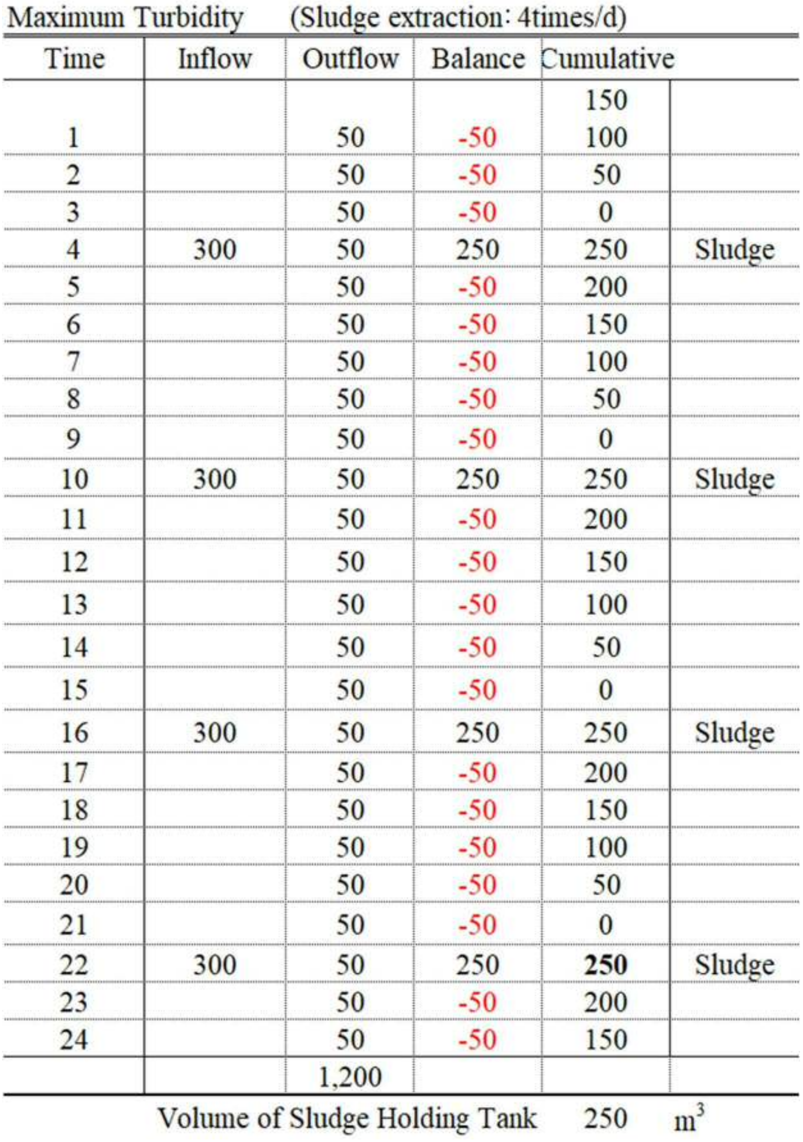
Waste Water Treatment

| | | Turbidity | Solid weight | Treatment flow | flow after treatment | Recycle Water | Solid weight | note |
|---|---|---|---|---|---|---|---|---|
| | | NTU | mg/l | m3/d | m3/d | m3/d | kg/d | |
| **Sludge Buffer** | inflow | | 8,500 | **1,180** | - | | 10,080 | Sludge content 0.85 % |
| **Tank** | outflow | | 8,500 | | 1,180 | | 10,080 | Loss: **2.5%** |
| **Sludge** | inflow | | 8,500 | **1,180** | | | 10,080 | Sludge content 0.85% |
| Thickener | outflow | | 30,000 | | 330 | | 9,900 | outflow to sludge drying bed 3% 28.3% |
| | | | 210 | | 850 | 850 | 180 | supernatant water (sludge content) 0.02% |
| **Sludge** | inflow | | 30,000 | **330** | | | **9,900** | |
| **Drying Bed** | inflow | | 329,000 | | 30 | | 9,870 | Dewatered sludge（sludge content) 35% |
| | | | 100 | | 300 | 300 | 30 | supernatant water |
| **Waste Water** | inflow | | 210 | | | 850 | 180 | Inflow from sludge thickener |
| **Tank** | | | 100 | | | 300 | 30 | Inflow from sludge drying bed |
| | | | 180 | | | **1,150** | 210 | Total of supenatant water |
| | outflow | | 180 | | | **1,150** | 210 | Turbidity of recycle water 0.02% (200mg/l) |
| | | | | | | 910 | 190 | from waste water tank |
| **Recycling** | inflow | | 1,150 | | | 1,150 | 210 | from Recycling Sump |
| | | | 200 | | | 45,840 | 9,170 | from Raw water 4.5% |
| | | | **200** | | | **47,900** | 9,570 | Total inflow |

Loss in Treatment Process

| | | | |
|---|---|---|---|
| Clarifier: Treatment capacity | 47,900 m3/d | Filter: Treatment capacity | 46,690 m3/d |
| Turbidity | 200 NTU | No. of filter for wash | 4 filters/d |
| Alum Dosage (8% liquid Alum) | 66 mg/l | Filter area | 42.3 m2 |
| Solid | 10,320 kg/d | Washing rate & time | |
| Sludge extraction | | initial w/air | 0.25 x 2min |
| Effluent to filter | 5 mg/l | backwashing | 0.5 x 8min |
| or 17,700 x 5/(350+80x0.234) = | 236 kg/d | Wahing waste water | 190 m3/filter |
| | 3% | | 760 m3/d |
| Sludge content | 1% | Allowance | 20% |
| Sludge volume | 1,010 m3/d | | 910 m3/d |
| Allowance for design of | 20% | Loss of Backwash waste water | 1.9% |
| | 1210 m3/d | Solid content in backwash waste water | |
| Loss of sludge extraction | 2.5% | Turbidity of filtered water | 1 mg/l |
| | | Solid | 190 kg/d |
| | | Solid content | 173 mg/l |
| Clear Water Reservoir | | | |
| Sludge content of filtered water | 1 mg/l | Total loss in treatment process | 2,310 m3/s |
| Minor water loss for plant operation | 0.4% | | 5% |
| Loss of water | 190 m3/d | | |

## Attached Table 1-3a Volume of Sludge Buffer Tank



Maximum Turbidity (Sludge extraction: 4times/d)

| Time | Inflow | Outflow | Balance | Cumulative | |
|---|---|---|---|---|---|
| | | | | 150 | |
| 1 | | 50 | -50 | 100 | |
| 2 | | 50 | -50 | 50 | |
| 3 | | 50 | -50 | 0 | |
| 4 | 300 | 50 | 250 | 250 | Sludge |
| 5 | | 50 | -50 | 200 | |
| 6 | | 50 | -50 | 150 | |
| 7 | | 50 | -50 | 100 | |
| 8 | | 50 | -50 | 50 | |
| 9 | | 50 | -50 | 0 | |
| 10 | 300 | 50 | 250 | 250 | Sludge |
| 11 | | 50 | -50 | 200 | |
| 12 | | 50 | -50 | 150 | |
| 13 | | 50 | -50 | 100 | |
| 14 | | 50 | -50 | 50 | |
| 15 | | 50 | -50 | 0 | |
| 16 | 300 | 50 | 250 | 250 | Sludge |
| 17 | | 50 | -50 | 200 | |
| 18 | | 50 | -50 | 150 | |
| 19 | | 50 | -50 | 100 | |
| 20 | | 50 | -50 | 50 | |
| 21 | | 50 | -50 | 0 | |
| 22 | 300 | 50 | 250 | **250** | Sludge |
| 23 | | 50 | -50 | 200 | |
| 24 | | 50 | -50 | 150 | |
| | | 1,200 | | | |

Volume of Sludge Holding Tank 250 $m^3$

## Attached Table 1-3b Volume of Waste Water Tank

(filter wahing: 4 time/d, continuous inflow of supernatant)

| Time | Infdlow | | | | Outflow | Balance | Cumulative |
|---|---|---|---|---|---|---|---|
| | Backwash Waste Water | Spernatant1 | Spernatant 2 | Total | | | 228 |
| 1 | | 35 | 13 | 48 | 86 | -38 | 190 |
| 2 | | 35 | 13 | 48 | 86 | -38 | 152 |
| 3 | | 35 | 13 | 48 | 86 | -38 | 114 |
| 4 | | 35 | 13 | 48 | 86 | -38 | 76 |
| 5 | | 35 | 13 | 48 | 86 | -38 | 38 |
| 6 | | 35 | 13 | 48 | 86 | -38 | 0 |
| 7 | 228 | 35 | 13 | 275 | 86 | 190 | 190 |
| 8 | | 35 | 13 | 48 | 86 | -38 | 152 |
| 9 | | 35 | 13 | 48 | 86 | -38 | 114 |
| 10 | | 35 | 13 | 48 | 86 | -38 | 76 |
| 11 | 228 | 35 | 13 | 275 | 86 | 190 | 266 |
| 12 | | 35 | 13 | 48 | 86 | -38 | 228 |
| 13 | | 35 | 13 | 48 | 86 | -38 | 190 |
| 14 | | 35 | 13 | 48 | 86 | -38 | 152 |
| 15 | 228 | 35 | 13 | 275 | 86 | 190 | 342 |
| 16 | | 35 | 13 | 48 | 86 | -38 | 304 |
| 17 | | 35 | 13 | 48 | 86 | -38 | 266 |
| 18 | | 35 | 13 | 48 | 86 | -38 | 228 |
| 19 | 228 | 35 | 13 | 275 | 86 | 190 | **418** |
| 20 | | 35 | 13 | 48 | 86 | -38 | 380 |
| 21 | | 35 | 13 | 48 | 86 | -38 | 342 |
| 22 | | 35 | 13 | 48 | 86 | -38 | 304 |
| 23 | | 35 | 13 | 48 | 86 | -38 | 266 |
| 24 | | 35 | 13 | 48 | 86 | -38 | 228 |
| | 910 | 850 | 300 | 2,060 | 2,060 | -0 | |

Volume of Waste Water Tank 418

Backwash waste water and supernatant inflow

(refer to Attached Table 1-2 Mass balance)

| | | | |
|---|---|---|---|
| backwash waste water | | 910 m3/d | 4times/d |
| Supernatant 1 | Sludge Thickener: | 850 m3/d | 24hours continuous |
| Supernatant 2 | Sludge Drying Bed: | 300 m3/d | 24hours continuous |

## Attachment 1-1 Sludge Extraction of Sedimentation Tank

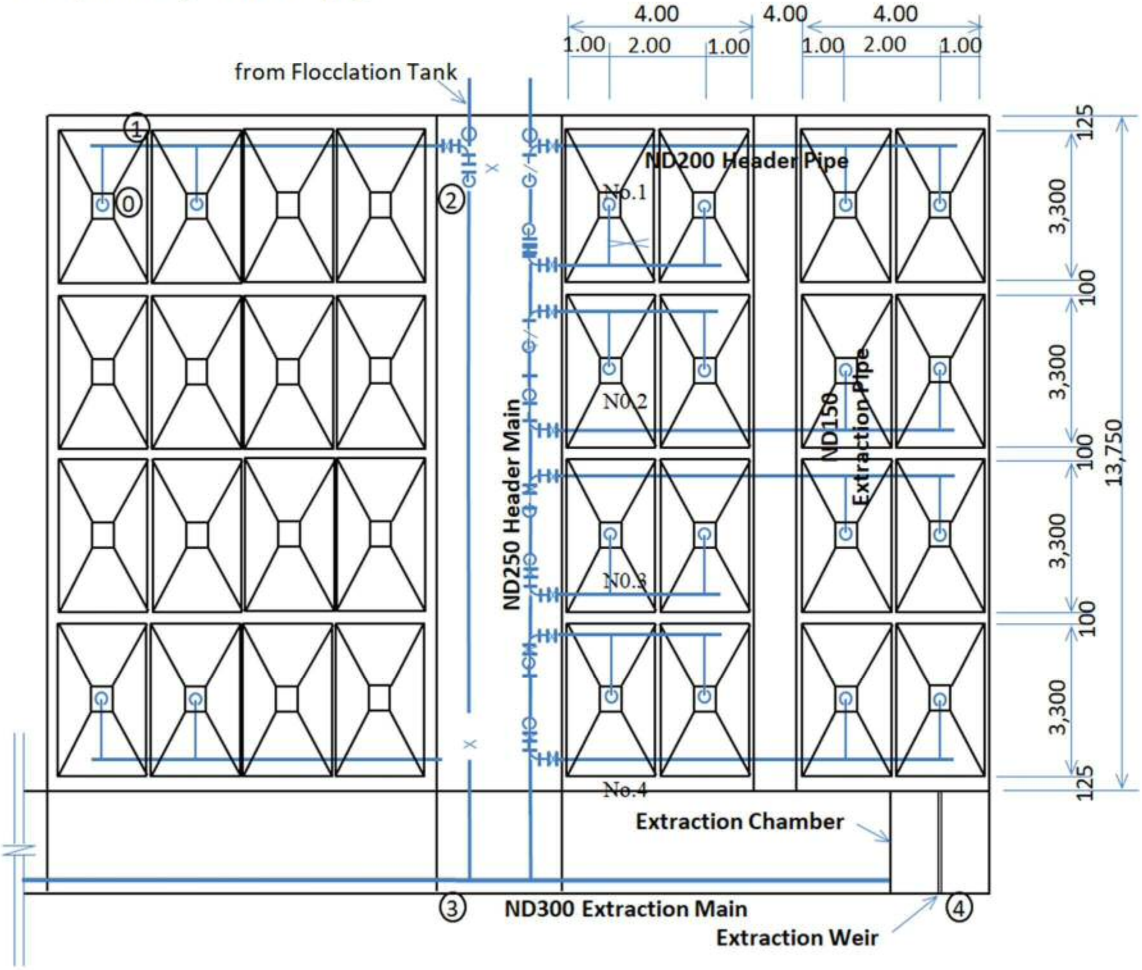
### 1 Sludge Volume

| Turbidity | | Maximum Turbidity | | | Annual Average Turbidity | | |
|---|---|---|---|---|---|---|---|
| | | Flow($m^3$/d) | Turbidity(NTU) | Sludge (kg) | Flow($m^3$/d) | Turbidity(NTU) | Sludge (kg) |
| | | 47,900 | 200 | 10,010 | 47,900 | 45 | 2,300 |
| Flocculation Tank | 5.0% | | | 501 | | | 115 |
| Settling Tank | 95.0% | | | 9,510 | | | 2,185 |
| | | | | | | | |
| Sludge | | | | | | | |
| Sludge content (extraction): | | | | 1% | | | 0.5% |
| Sludge volume (m3/d) | | | | 1,001 | | | 437 |
| Flocculation Tank | | | | 50 | | | 22 |
| Settling Tank | | | | 951 | | | 415 |

note: It is assumed that 5% of sludge is settled in the Floccutation Tank and remaining of 95% is in the Settling Tank.

### 2 Sludge Extraction

2.1 Layout of Sludge Extraction Piping



## 2.2 Sludge Extraction

| | |
|---|---|
| Number of tank for Simultaneous Sludge Extraction | 1 tank |
| Sludge Extraction per day | 1 times/d |
| Interval of Sludge Extraction per Tank | 6 h |
| per sludge hopper (simultaneous extraction from 2 hoppers) | 45 min |

## 2.3 Sludge Extraction Hydraulics

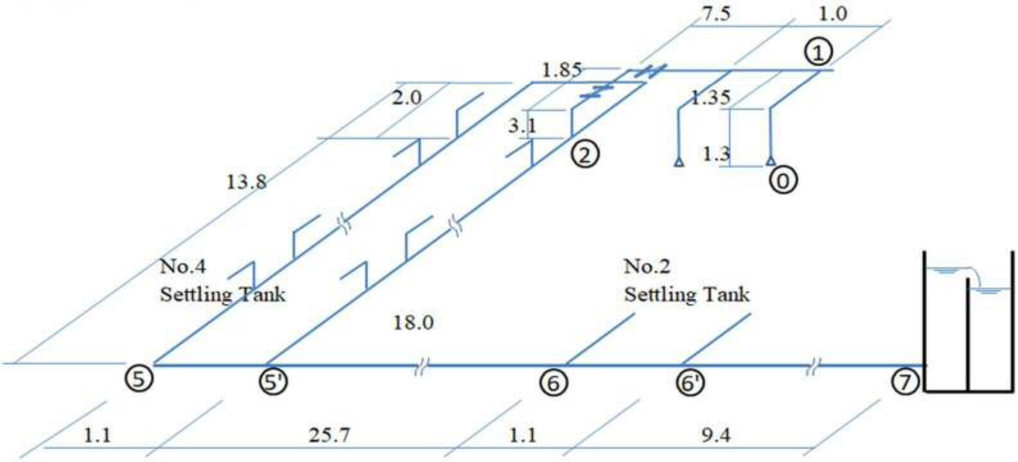
### 1) Levels

| | | | |
|---|---|---|---|
| Water level of Sedimentation Tank (ST) | | + | 187.32 m |
| Overflow Weir Tip Level of Sludge Extraction Chamber (SEC) | | + | 185.76 m |
| Level Deference | Overflow height of weir | | 0.14 m |
| | Water level of ST - Overflow height of SEC) | | 1.42 m |

### 2) Sludge Extraction Flow and Extraction Time

| | | |
|---|---|---|
| Sludge extraction flow | per a hopper | 35.1 l/s |
| Sludge extraction time | per two hopper2 ホッパー当たり | 7.1 min |
| | per tank | 1.5 h |

### 3) Hydraulic Analysis



(Max. Turbidity)

section 0 ~ 1: Q = q l/s ND: 150 mm length: 2.65 m

$h1 = (fi + fb + f*l/d) * v1^2/2g =$ $405.4\ q^2$

where, fi = 0.5 fb90 = 0.3

fbe = 1.1 (fbe + fse) f x l/d = 0.60

$V^2/2g =$ $163.5\ q^2$

section 1 ~ 2: Q = q l/s ND: 200 mm length-1: 1 m

Q = 2q l/s ND: 200 mm length-1: 12.45 m

$h2 = f1 \times l1/d \times v1^2/2g + (f2 \times l2/d + f\gamma + 2 \times fb90 + fv + fbe) \times v2^2/2g =$

$491.1\ q^2$

| | | | |
|---|---|---|---|
| where, f1 x l1/d = | 0.15 | f2 x l2/d = | 1.91 |
| | | fγ = | 0.87 |
| | | fb90 = | 0.3 |
| | | fv = | 0.3 (B.V) |
| | | fbe = | 0.99 |

$f\gamma = -(q\beta)^2 \times \{2.59+1.62x(-1) - 0.62x\varphi\} - q\beta x(1.94-\varphi) + 0.03$

where, qβ = 0.5 φ = 0.56

= 0.874 Dβ: 150 Dγ: 200

$V1^2/2g =$ $51.7\ q^2$ $V2^2/2g =$ $103.5\ q^2$

section 2 ~ 5: Q = 2q l/s ND: 200 mm length: -

Q = 2q l/s ND: 250 mm length: 13.8 m

h3 = fse1 x $V1^2/2g$ +(f x l/d + 3fbe + fse2) x $V2^2/2g$ = 85.5 $q^2$

where, fse1 = 0.13 (D1/D2 = 0.8) f x l/d = 0.62

fbe = 0.99

fse2 = 0.09 (D1/D2 = 0.83)

$V1^2/2g$ = 103.5 $q^2$ $V2^2/2g$ = 42.4 $q^2$

section 5 ~ 6: Q = 2q l/s ND: 300 mm length: 37.3 m

h4 = (f1 x l1/d + fo) x $V^2/2g$ = 101.8 $q^2$

where, f1 x l1/d = 1.49 fo = 1.0

$V^2/2g$ = 40.89 $q^2$

Weir Loss: Q = 2q l/s

hw = (Q/CW)^2/3 = 0.81 $q^{\wedge 2/3}$

where, C = 1.84 (approx.)

W = 1.5 m (weir length)

Total Head Loss:

ΔH = h1 + h2 + h3 + h4 + h5 + hw = 1.5 m

= 1,083.8 $q^2$ + 0.81 $q^{\wedge 2/3}$

Sludge Extraction

Extraction time 1 times/d

Interval of Sludge Extraction per tanl 6.0 hrs/tank

per hoper 45 min/two hoppers

extraction valve 2 hoppers/valve

WL of Sedimentation Tank + **187.32**

Extraction Volume 951 m3/time

3.7 *m3/d/hopper

note*: solid content in hopper is assumed as 4%

| | | | | |
|---|---|---|---|---|
| | | 1.41005 | 1.42005 | 1.43001 |
| ΔH | m | 1.41 | 1.42 | 1.43 |
| Flow (q) | l/s | 34.95 | 35.07 | 35.20 |
| Flow (2q) | l/s | 69.90 | 70.10 | 70.40 |
| Time | min. | | | |
| Over flow height | m | 0.137 | 0.138 | 0.138 |
| Weir Level | m | 185.77 | **185.76** | 185.75 |
| Interval of S. Extraction | | | | |
| per tank | hour | 6 | 6 | 6 |
| per hopper | min | 45 | 45 | 45 |
| Extraction time | | | | |
| per tank | hour | 1 | 1 | 1 |
| per hopper | min | 7.09 | 7.06 | 7.03 |
| Velocity & H.Gradient | | | | |
| | ND150 | | | |
| Velocity | m/s | 1.978 | 1.986 | 1.993 |
| H.Gradient | ‰ | 44.2 | 44.5 | 44.8 |
| | ND200 | | | |
| Velocity | m/s | 2.226 | 2.232 | 2.242 |
| H.Gradient | ‰ | 78.5 | 79.6 | 79.6 |
| | ND250 | | | |
| Velocity | m/s | 1.425 | 1.429 | 1.435 |
| H.Gradient | ‰ | 13.3 | 13.3 | 13.4 |
| | ND300 | | | |
| Velocity | m/s | 0.989 | 0.992 | 0.996 |
| H.Gradient | ‰ | 5.5 | 5.5 | 5.5 |

# ２．Raw Water Quality and Chemical Dosage

# 2 Raw Water Quality and Chemical Dosage

## 2.1 Raw Water Quality

### (1) Raw Water Quality Data

Existing old Jhal Khanuana water treatment plant (Old JK WTP: slow sand filtration plant) takes raw water from Rakh Branch Canal (RBC). High turbid raw water is reduced its turbidity in Raw Water Storage Reservoirs (RWSRs) for slow sand filtration. The planned rapid filtration plan will continues to intakes the same raw water source.

At the down stream of RBC, rapid sand filtration plant named New Jhal Kanuana Water Treatment Plant (New JK WTP) constructed under the financial aid of French Government is in operation using the same raw water. Water quality data from both water treatment plant, therefore available.

Important water quality parameters for plant design include water temperature, pH, turbidity, alkalinity. Inanition, water quality parameters of ammonium, iron and manganese are also required to grasp chlorine consumption.

Water quality Data of water temperature, pH and turbidity during 2012 ~ 14 period is available from Old JK WTP. And from New JK WTP, daily data is also available for the same water quality parameters during 2016 ~ 18 period. These data is presented in Attached Table 2-1 and 2-2.

Only limited water quality data is available for ammonium, iron and manganese. These water quality parameters are available from Master Plan Study as shown in Attached Table 2-3.

The present plan uses the existing RWSRs to reduce high turbidity of raw water for treatment. The effect of RWSR is able to estimate by comparing turbidities between raw water (canal water) and clarified water by RWSR. Data of Old JK WTP in 2012 ~ 14 show the reduction rate as 60 ~ 90% for raw water turbidity of 50 NTU or lower. For high turbidity raw water, the reduction rate is 80 ~ 90% against raw water turbidity of 50 ~ 500 NTU and very high rate of 96% ~ 97% for raw water turbidity of 500 ~ 800 NTU. These data may indicate large detention time of RWSR affect the above high turbidity reduction rate. However, these data varied widely as shown in Attached Table 2-1.

In the second site survey, settling test was carried out to grasp the effect of RWSR reduction of high turbidity of raw water. The rest results are shown in attached table 2-4 and summarized as follows:.

- Existing two RWSRs are available, each having detention time as 24 hours against planed treatment capacity of 47.900 $m^3$/d.
- The test results show the following reduction of turbidity ranging 80 ~ 800 NTU and settling time.

| Turbidity NTU | 800 | 600 | 400 | 190 | 80 |
|---|---|---|---|---|---|
| Settling time (hour) | | | | | |
| 6 | 320 | 116 | 185 | 58 | 47 |
| 12 | 185 | 71 | 93 | - | - |
| 24 | 76 | 41 | 63 | 16 | 24 |

- From the above test results, it is estimated that 90% of reduction rate for high turbid water of 500 NTU or more and 70% of reduction rate for turbidity of 100 NTU or less in 24 hours settling time.

Following reduction rate of raw water is estimated taking the settling efficiency of RWSR into account.

| Raw Water Turbidity (NTU) | < 50 | 100 | 150 | 250 | > 500 |
|---|---|---|---|---|---|
| Reduction Rate | 60% | 65% | 70% | 75% | 80% |

The estimated turbidity reduced in RWSR for one year is presented in Attached Table 2-5 using annual data of turbidity in 2017/18 obtained from New JK WTP.

For other water quality parameters of alkalinity, ammonium, iron and manganese, the following test results are shown in below table (refer to attached table 2-3).

| | | Water Quality Parameters | | | |
|---|---|---|---|---|---|
| Data ource | Water Source | Alkalinity | Iron | manganese | Ammonium |
| | | mg/l | mg/l | mg/l | mg/l |
| Panjab prvince (2009) | Cenab River[*1] | - | 0.81 | 0.02 | - |
| WSA-F (2013 ~ 16) | RBC[*2] | - | - | - | 0.3 |
| | | | | | (0.1 ~ 0.5) |
| JICA Team (2016) | Cenab River | 110 ~ 133 | 0.18 ~ 0.3 | < 0.01 | < 0.01 |
| in Master Plan Study | RBC[*2] | 70 ~ 120 | 0.36 ~ 0.8 | < 0.01 | < 0.01 |

Note[*1]: Water Source of RBC

[*2]: Rakh Branch Canal figures in paresis show minimum~maximum

(2) Estimated Water Quality

Raw water of RBS is planned to be transfer to RWSR and water is treated using clarified water in RWSR. Turbidity of raw water will be therefore reduced significantly, on the other hand little change is expected for such water quality parameters as water temperature, pH, alkalinity, ammonium, iron and manganese. Reduction of turbidity will affect largely for chemical consumption for coagulation. On the other hand chlorine consumption will not be affected due to little change of ammonium, iron and manganese RWSR which affect chlorine consumption.

Future water quality is estimated for chemical application plan as shown in below table.

| Water Quality Parameter | unit | Future Plan（2038） | | |
|---|---|---|---|---|
| | | Maximum | Average | Minimum |
| Water temperature | ℃ | 30 | 33 | 11 |
| pH | - | 8.7 | 8.2 | 7.6 |
| Turbidity | NTU | 200 | 48 | 10 |
| Alkalinity | mg/l | 120 | 90 | 70 |
| Ammonium | mg/l | 0.05 | 0.03 | 0.01 |
| Iron | mg/l | 0.8 | 0.5 | 0.3 |
| Manganese | mg/l | 0.05 | 0.02 | 0.01 |

Note: Past water quality data (2017 ~ 2019) of RBC shows that high turbidities (more than 1000 NTU) occurs 1 ~ 5 times in July ~ August period, where the maximum turbidity was 1400 NTU. In design of water treatment, 1000 NTU is used as the maximum turbidity for consideration of economy.